Risks of Phosmet Use to Federally Threatened California Red-legged Frog
(*Rana aurora draytonii*)

Pesticide Effects Determination

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Washington, D.C. 20460

June 18, 2008

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Acknowledgement

The phosmet chemical team would like to acknowledge the contribution of the California red-legged frog Steering Committee in compiling detailed information on the threatened species. Additionally, the Steering Committee has provided invaluable guidance toward achieving greater consistency in format and content between chemicals being assessed. We acknowledge the contribution of Ms. Michelle Thawley, Mr. Kurt Pluntke, and Ms. Megan Thynge in providing the Geographic Information System analysis used to define the potential overlap between California red-legged frog and their designated critical habitat within the action area.

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1. Executive Summary

The purpose of this assessment is to evaluate potential direct and indirect effects on the California red-legged frog (*Rana aurora draytonii*) (CRLF) arising from Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) regulatory actions regarding the registered uses of phosmet. In addition, this assessment evaluates whether these actions can be expected to result in modification of the species' designated critical habitat. This assessment was completed in accordance with the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) ('the Services') *Endangered Species Consultation Handbook* (USFWS/NMFS 1998) and procedures outlined in the Agency's Overview Document (USEPA 2004).

The CRLF was listed as a threatened species by USFWS in 1996. The species is endemic to California and Baja California (Mexico) and inhabits both coastal and interior mountain ranges. A total of 243 streams or drainages are believed to be currently occupied by the species, with the greatest numbers in Monterey, San Luis Obispo, and Santa Barbara counties (USFWS 1996) in California.

Phosmet is a restricted–use, organophosphate insecticide that is currently labeled for use on alfalfa, orchard crops (*e.g.* almonds, walnuts, apples, cherries), blueberries, citrus, cotton, grapes, ornamental trees and non-bearing fruit trees, Christmas trees, potatoes and truck vegetable crops. The current uses are considered as part of the federal action evaluated in this assessment.

Phosmet has relatively low volatility and is soluble in water. Therefore, potential transport mechanisms considered in this assessment are limited to spray drift and runoff, as volatilization and atmospheric transport are not expected to occur. The compound is slightly mobile to moderately mobile in soils and is expected to dissipate rapidly in the environment. Phosmet is subject to rapid hydrolysis under alkaline and neutral conditions and to lesser extent under acidic conditions. Microbial-mediated degradation may also be a route of degradation.

Phosmet oxon, the only environmental degradate of phosmet that has been identified as having toxicological concern, has been detected in six ambient water monitoring samples reported in the USGS NAWQA program with estimated concentrations ranging from 0.0069 to 0.0453 µg/L. Phosmet oxon was identified in only minor amounts (≤0.5%) in the environmental fate studies and its formation and decline in the environment is not characterized well enough to estimate environmental concentrations. There are currently no ecological toxicity data available for phosmet oxon however, the oxon degradates of other organophosphate pesticides have been reported equally or more toxic than their parent compounds. This assessment quantitatively considered exposures to phosmet parent only, but potential risk resulting from exposure to the oxon is discussed in the risk description.

Since CRLFs exist within aquatic and terrestrial habitats, exposure of the CRLF, its prey and its habitats to phosmet are assessed separately for the two habitats. The Tier-II aquatic exposure models Pesticide Root Zone Model (PRZM) and EXposure Analysis Modeling System (EXAMS) are used to estimate high-end exposures of phosmet in aquatic habitats resulting from runoff and spray drift from different uses. Peak aquatic model-estimated environmental concentrations (EEC) resulting from different phosmet uses range from 3.52 to 78.2 µg/L. These estimates are supplemented with analysis of available California surface water monitoring data from the U. S. Geological Survey's National Water Quality Assessment (NAWQA) program and the California Department of Pesticide Regulation (DPR) surface water database. However, predicted exposure estimates from PRZM/EXAMS cannot be directly compared with the monitoring data because there are no monitoring data that specifically targeted phosmet use. There were two detections of phosmet reported by the California Department of Pesticide Regulation surface water database at 0.3 and 0.63 µg/L (these values would result in exceedances of the listed species LOC for aquatic invertebrates). However, no detections of phosmet were reported by NAWQA for surface waters across the United States.

To estimate phosmet exposures to the terrestrial-phase CRLF, and its potential prey resulting from uses involving phosmet applications, the Terrestrial Residue EXposure (T-REX) model is used for foliar treatment uses. The TerrPlant model is used to estimate phosmet exposures to terrestrial-phase CRLF habitat, including plants inhabiting semi-aquatic and dry areas, resulting from uses involving foliar phosmet applications. The Terrestrial Herpetofaunal Exposure and Residue Program Simulation (T-HERPS) model is used to allow for further characterization of dietary exposures of terrestrial-phase CRLFs.

The assessment endpoints for the CRLF include direct toxic effects on the survival, reproduction, and growth of the CRLF itself, as well as indirect effects, such as reduction of the prey base or modification of its habitat. Direct effects to the CRLF in the aquatic habitat are based on toxicity information for freshwater fish, which are generally used as a surrogate for aquatic-phase amphibians. In the terrestrial habitat, direct effects are based on toxicity information for birds, which are used as a surrogate for terrestrial-phase amphibians. Given that the CRLF's prey items and designated critical habitat requirements in the aquatic habitat are dependant on the availability of freshwater aquatic invertebrates and aquatic plants, toxicity information for these taxonomic groups is also discussed. In the terrestrial habitat, indirect effects due to depletion of prey are assessed by considering effects to terrestrial insects, small terrestrial mammals, and frogs. Indirect effects due to modification of the terrestrial habitat are characterized by using available organophosphate insecticide data for terrestrial plants.

Risk quotients (RQs) are derived as quantitative estimates of potential high-end risk. Acute and chronic RQs are compared to the Agency's levels of concern (LOCs) to identify instances where phosmet use within the action area has the potential to adversely affect the CRLF and its designated critical habitat via direct toxicity or indirectly based on direct effects to its food supply (*i.e.*, freshwater invertebrates, algae, fish, frogs, terrestrial invertebrates, and mammals) or habitat (*i.e.*, aquatic plants and terrestrial upland and riparian vegetation). When RQs for each particular type of effect are below LOCs, the pesticide is determined to have "no effect" on the CRLF. Where RQs exceed LOCs, a potential to cause adverse effects is identified, leading to a conclusion of "may affect." If a determination is made that use of phosmet use within the action area "may affect" the CRLF and its designated critical habitat, additional information is considered to refine the potential for exposure and effects, and the best available information is used to distinguish those actions that "may affect, but are not likely to adversely affect" (NLAA) from those actions that are "likely to adversely affect" (LAA) the CRLF and its critical habitat.

Based on the best available information, the Agency makes a 'May Affect and Likely to Adversely Affect (LAA)' determination for the CRLF from the registered uses of phosmet. Additionally, the Agency has determined that there is the potential for 'habitat modification (HM)' of CRLF designated critical habitat from the use of the chemical. The use of phosmet as an insecticide is likely to directly adversely affect both the aquatic- and terrestrial-phase CRLF through acute and chronic effects. Additionally, as expected with an insecticide, phosmet is likely to adversely affect the invertebrate prey base for both the aquatic- and terrestrial-phase CRLF. Phosmet may affect terrestrial-phase CRLF habitat through reductions in terrestrial plants that serve as cover. A decrease in terrestrial plants along riparian zones is also likely to adversely affect the aquatic-phase CRLF through indirect effects on water quality. Based on this assessment, the use of phosmet is also likely to modify the principle constituent elements (PCEs) of designated critical habitat for both aquatic- and terrestrial-phase CRLF. A summary of the risk conclusions and effects determinations for the CRLF and its critical habitat is presented in **Tables 1.1** and **1.2**. Further information on the results of the effects determination is included as part of the Risk Description in Section 5.2.

Based on the conclusions of this assessment, a formal consultation with the U. S. Fish and Wildlife Service under Section 7 of the Endangered Species Act should be initiated.

Table 1.1 Effects Determination Summary for Direct and Indirect Effects of phosmet on the CRLF		
Assessment Endpoint	**Effects Determination[1]**	**Basis for Determination**
Aquatic-Phase CRLF (Eggs, Larvae, and Adults)		
Direct Effects: Survival, growth, and reproduction of CRLF individuals via direct effects on aquatic phases	**LAA**	RQ values for CRLF exceed the acute and chronic LOCs.
Indirect Effects: Survival, growth, and reproduction of CRLF individuals via effects to food supply (*i.e.*, freshwater invertebrates, non-vascular plants, fish, and frogs)	Freshwater invertebrates: **LAA**	RQ values for freshwater invertebrates exceed acute and chronic LOCs
	Non-vascular aquatic plants: **NLAA**	RQ values for non-vascular aquatic plants are below the LOC for all uses except fruit trees. Exposure estimates for the use on fruit trees is considered high end and when mitigated application rates are considered, RQ values for nonvascular plants from the use of phosmet on fruit trees would likely fall below the LOC.
	Fish and frogs: **LAA**	RQ values for freshwater vertebrates (fish and amphibians) exceed acute and chronic LOCs.
Indirect Effects: Survival, growth, and reproduction of CRLF individuals via indirect effects on habitat, cover, and/or primary productivity (*i.e.*, aquatic plant community)	Non-vascular aquatic plants: **NLAA**	RQ values for non-vascular aquatic plants are below the LOC for all uses except fruit trees. Exposure estimates for the use on fruit trees is considered high end and when mitigated application rates are considered, RQ values for nonvascular plants from the use of phosmet on fruit trees would likely fall below the LOC..
	Vascular aquatic plants: **NE**	RQ values for vascular aquatic plants are below the LOC.
Indirect Effects: Survival, growth, and reproduction of CRLF individuals via effects to riparian vegetation, required to maintain acceptable water quality and habitat in ponds and streams comprising the species' current range.	**LAA**	Terrestrial plant RQ values are exceeded and riparian vegetation may be adversely affected which in turn could indirectly affect water quality and habitat in ponds and streams comprising the species' current range.
Terrestrial-Phase CRLF (Juveniles and adults)		
Direct Effects: Survival, growth, and reproduction of CRLF individuals via direct effects on terrestrial phase adults and juveniles	**LAA**	Acute and chronic RQ values exceed the LOCs and have a likelihood of acute effects of up to 100%, depending on the use.
Indirect Effects: Survival, growth, and reproduction of CRLF individuals via effects on prey (*i.e.*, terrestrial invertebrates, small terrestrial vertebrates, including mammals and terrestrial phase amphibians)	Terrestrial invertebrates**:** **LAA**	Both small and large insect RQs exceed the LOC. Terrestrial insects serving as prey would have a likelihood of individual mortality of 100%.
	Mammals: **LAA**	Acute and chronic RQ values exceed the LOCs; therefore, the determination is for a likely to adversely affect (LAA) terrestrial-phase CRLF based on indirect adverse chronic effects on mammals serving as food for terrestrial-phase CRLF
	Frogs: **LAA**	Acute and chronic RQ values exceed the LOCs; therefore, the determination is for a likely to adversely affect (LAA) terrestrial-phase CRLF based on indirect adverse chronic effects on mammals serving as food for terrestrial-phase CRLF
Indirect Effects: Survival, growth, and reproduction of CRLF	**LAA**	Terrestrial plant RQ values, based on bridged data, exceed the LOC for semi-aquatic plants for all uses

individuals via indirect effects on habitat (*i.e.*, riparian vegetation)		

[1] NE = no effect; NLAA = may affect, but not likely to adversely affect; LAA = likely to adversely affect

Table 1.2 Effects Determination Summary for the Critical Habitat Impact Analysis

Assessment Endpoint	Effects Determination[1]	Basis for Determination
Aquatic-Phase CRLF PCEs (Aquatic Breeding Habitat and Aquatic Non-Breeding Habitat)		
Alteration of channel/pond morphology or geometry and/or increase in sediment deposition within the stream channel or pond: aquatic habitat (including riparian vegetation) provides for shelter, foraging, predator avoidance, and aquatic dispersal for juvenile and adult CRLFs.	**HM**	Although aquatic plants are not affected by the assessed uses of phosmet, terrestrial plants may be adversely affected from the use of phosmet. Reductions in the extent of riparian cover may lead to reductions in water quality due to increased runoff of sediments, decreased shading leading to increased water temperatures, and decreased structure
Alteration in water chemistry/quality including temperature, turbidity, and oxygen content necessary for normal growth and viability of juvenile and adult CRLFs and their food source.[1]	**HM**	
Alteration of other chemical characteristics necessary for normal growth and viability of CRLFs and their food source.	**HM**	
Reduction and/or modification of aquatic-based food sources for pre-metamorphs (*e.g.*, algae)	**HM**	RQ values for freshwater vertebrates (fish and amphibians) exceed both the acute and chronic LOCs.
Terrestrial-Phase CRLF PCEs (Upland Habitat and Dispersal Habitat)		
Elimination and/or disturbance of upland habitat; ability of habitat to support food source of CRLFs: Upland areas within 200 ft of the edge of the riparian vegetation or dripline surrounding aquatic and riparian habitat that are comprised of grasslands, woodlands, and/or wetland/riparian plant species that provides the CRLF shelter, forage, and predator avoidance	**HM**	Terrestrial plant RQ values exceed the LOC. Because terrestrial plants may be adversely affected by phosmet, the determination is for a likely to adversely affect the two terrestrial-phase PCE through disturbance of upland habitat to support food sources of CRLF and through elimination and/or disturbance of dispersal habitat.
Elimination and/or disturbance of dispersal habitat: Upland or riparian dispersal habitat within designated units and between occupied locations within 0.7 mi of each other that allow for movement between sites including both natural and altered sites which do not contain barriers to dispersal	**HM**	
Reduction and/or modification of food sources for terrestrial phase juveniles and adults	**HM**	As an insecticide, reductions in the prey base of terrestrial-phase CRLF are likely; therefore, the determination is for a likely to adversely affect (LAA) the third terrestrial-phase CRLF PCE through reduction and/or modification of food sources for terrestrial-phase juvenile and adult CRLF.
Alteration of chemical characteristics necessary for normal growth and viability of juvenile and adult CRLFs and their food source.	**HM**	Indirect effects through reductions in the availability of its food items are considered likely to adversely affect the species; therefore, the determination is for a likely to adversely affect (LAA) the fourth terrestrial-phase PCE.

[1] NE = No effect; HM = Habitat modification

When evaluating the significance of this risk assessment's direct/indirect and adverse habitat modification effects determinations, it is important to note that pesticide

[1] Physico-chemical water quality parameters such as salinity, pH, and hardness are not evaluated because these processes are not biologically mediated and, therefore, are not relevant to the endpoints included in this assessment.

exposures and predicted risks to the species and its resources (*i.e.*, food and habitat) are not expected to be uniform across the action area. In fact, given the assumptions of drift and downstream transport (*i.e.*, attenuation with distance), pesticide exposure and associated risks to the species and its resources are expected to decrease with increasing distance away from the treated field or site of application. Evaluation of the implication of this non-uniform distribution of risk to the species would require information and assessment techniques that are not currently available. Examples of such information and methodology required for this type of analysis would include the following:

- Enhanced information on the density and distribution of CRLF life stages within specific recovery units and/or designated critical habitat within the action area. This information would allow for quantitative extrapolation of the present risk assessment's predictions of individual effects to the proportion of the population extant within geographical areas where those effects are predicted. Furthermore, such population information would allow for a more comprehensive evaluation of the significance of potential resource impairment to individuals of the species.
- Quantitative information on prey base requirements for individual aquatic- and terrestrial-phase frogs. While existing information provides a preliminary picture of the types of food sources utilized by the frog, it does not establish minimal requirements to sustain healthy individuals at varying life stages. Such information could be used to establish biologically relevant thresholds of effects on the prey base, and ultimately establish geographical limits to those effects. This information could be used together with the density data discussed above to characterize the likelihood of adverse effects to individuals.
- Information on population responses of prey base organisms to the pesticide. Currently, methodologies are limited to predicting exposures and likely levels of direct mortality, growth or reproductive impairment immediately following exposure to the pesticide. The degree to which repeated exposure events and the inherent demographic characteristics of the prey population play into the extent to which prey resources may recover is not predictable. An enhanced understanding of long-term prey responses to pesticide exposure would allow for a more refined determination of the magnitude and duration of resource impairment, and together with the information described above, a more complete prediction of effects to individual frogs and potential modification to critical habitat.

2. Problem Formulation

Problem formulation is intended to provide a strategic framework for an ecological risk assessment. By identifying the important components of potential ecological risk, it focuses the assessment on the most relevant life history stages of affected organisms, habitat components, chemical properties, exposure routes, and endpoints. The structure of this ecological risk assessment is based on guidance contained in U.S. EPA's *Guidance for Ecological Risk Assessment* (USEPA 1998), the Services' *Endangered Species Consultation Handbook* (USFWS/NMFS 1998) and is consistent with procedures and methodology outlined in the Overview Document (USEPA 2004) and reviewed by the U.S. Fish and Wildlife Service and National Marine Fisheries Service (USFWS/NMFS 2004).

2.1 Purpose

The purpose of this threatened species assessment is to evaluate potential direct and indirect effects on individuals of the federally-listed threatened California red-legged frog (*Rana aurora draytonii*), hereafter referred to as the CRLF, arising from FIFRA regulatory actions regarding use of phosmet (PC Code 059201) on alfalfa, orchard crops (*e.g.* almonds, walnuts, apples, cherries), blueberries, citrus, cotton, grapes, ornamental trees and non-bearing fruit trees, Christmas trees, potatoes and truck vegetables. In addition, this assessment evaluates whether use on these crops or areas is expected to result in modification of the species' designated critical habitat. This ecological risk assessment has been prepared consistent with a settlement agreement in the case *Center for Biological Diversity (CBD) vs. EPA et al*. (Case No. 02-1580-JSW(JL)) settlement entered in Federal District Court for the Northern District of California on October 20, 2006.

In this assessment, direct and indirect effects to the CRLF and potential modification to its designated critical habitat are evaluated in accordance with the methods described in the Agency's Overview Document (USEPA 2004). Screening level methods include use of standard models such as PRZM-EXAMS, T-REX, TerrPlant, and AGDISP, all of which are described at length in the Overview Document. Additional refinements include an analysis of the usage data, a spatial analysis, and use of the T-HERPS model to predict concentrations of phosmet on terrestrial-phase CRLF food items. Use of such information is consistent with the methodology described in the Overview Document (USEPA 2004), which specifies that "the assessment process may, on a case-by-case basis, incorporate additional methods, models, and lines of evidence that EPA finds technically appropriate for risk management objectives" (Section V, page 31 of USEPA 2004).

In accordance with the Overview Document, provisions of the ESA, and the Services' *Endangered Species Consultation Handbook,* the assessment of effects associated with registrations of phosmet is based on an action area. The action area is the area directly or indirectly affected by the federal action, as indicated by the exceedance of the Agency's Levels of Concern (LOCs). It is acknowledged that the action area for a national-level

FIFRA regulatory decision associated with a use of phosmet may potentially involve numerous areas throughout the United States and its Territories. However, for the purposes of this assessment, attention will be focused on relevant sections of the action area including those geographic areas associated with locations of the CRLF and its designated critical habitat within the state of California.

As part of the "effects determination," one of the following three conclusions will be reached regarding the potential use of phosmet in accordance with current labels:

- "No effect";
- "May affect, but not likely to adversely affect"; or
- "May affect and likely to adversely affect".

Designated critical habitat identifies specific areas that have the physical and biological features, (known as primary constituent elements or PCEs) essential to the conservation of the listed species. The PCEs for CRLFs are aquatic and upland areas where suitable breeding and non-breeding aquatic habitat is located, interspersed with upland foraging and dispersal habitat.

If the results of initial screening-level assessment methods show no direct or indirect effects (no LOC exceedances) upon individual CRLFs or upon the PCEs of the species' designated critical habitat, a "no effect" determination is made for use of phosmet as it relates to this species and its designated critical habitat. If, however, potential direct or indirect effects to individual CRLFs are anticipated or effects may impact the PCEs of the CRLF's designated critical habitat, a preliminary "may affect" determination is made for the FIFRA regulatory action regarding phosmet.

If a determination is made that use of phosmet within the action area(s) associated with the CRLF "may affect" this species or its designated critical habitat, additional information is considered to refine the potential for exposure and for effects to the CRLF and other taxonomic groups upon which these species depend (*e.g.,* aquatic and terrestrial vertebrates and invertebrates, aquatic plants, riparian vegetation, *etc.*). Additional information, including spatial analysis (to determine the geographical proximity of CRLF habitat and phosmet use sites) and further evaluation of the potential impact of phosmet on the PCEs is also used to determine whether modification of designated critical habitat may occur. Based on the refined information, the Agency uses the best available information to distinguish those actions that "may affect, but are not likely to adversely affect" from those actions that "may affect and are likely to adversely affect" the CRLF or the PCEs of its designated critical habitat. This information is presented as part of the Risk Characterization in Section 5 of this document.

The Agency believes that the analysis of direct and indirect effects to listed species provides the basis for an analysis of potential effects on the designated critical habitat. Because phosmet is expected to directly impact living organisms within the action area (defined in Section 2.7), critical habitat analysis for phosmet is limited in a practical sense to those PCEs of critical habitat that are biological or that can be reasonably linked to biologically mediated processes (*i.e.*, the biological resource requirements for the listed species associated with the critical habitat or important physical aspects of the habitat that may be reasonably influenced through biological processes). Activities that may modify critical habitat are those that alter the PCEs and could appreciably diminish the value of the habitat. Evaluation of actions related to use of phosmet that may alter the PCEs of the CRLF's critical habitat form the basis of the critical habitat impact analysis. Actions that may affect the CRLF's designated critical habitat have been identified by the Services and are discussed further in Section 2.6.

2.2 Scope

Phosmet is a non-systemic, rapid-acting cholinesterase inhibitor that kills insect pests on crops by contact and ingestion. Phosmet is generally applied 1-10 times per year directly to the target crop, although label limits are not stated for all use patterns. Application methods are typically aerial or ground spray, but depending on the use pattern, include chemigation and airblast.

The end result of the EPA pesticide registration process (*i.e.*, the FIFRA regulatory action) is an approved product label. The label is a legal document that stipulates how and where a given pesticide may be used. Product labels (also known as end-use labels) typically describe the formulation type (*e.g.*, liquid or granular), acceptable methods of application, approved use sites, and any restrictions on how applications may be conducted. Thus, the use or potential use of phosmet in accordance with the approved product labels for California is "the action" relevant to this ecological risk assessment.

Although current registrations of phosmet allow for use nationwide on most crops, this ecological risk assessment and effects determination addresses currently registered uses of phosmet in portions of the action area that are reasonably assumed to be biologically relevant to the CRLF and its designated critical habitat. Further discussion of the action area for the CRLF and its critical habitat is provided in Section 2.7.

Phosmet oxon, which was identified only in minor amounts (<0.5%) in the environmental fate studies, is the only identified environmental degradate of toxicological concern. The only major degradate identified in the environmental fate studies was phthalamic acid. A number of other minor degradates were identified in the aerobic and anaerobic soil metabolism and hydrolysis studies. These degradates are various conjugates of the phthalimide, phthalamic acid, and phthalic acid moieties of the parent. With the exception of phosmet oxon, all the other identified degradates have lost the organophosphate moiety and are not expected to have acetylcholinesterase inhibition activity.

There are currently no ecotoxicity data for phosmet oxon; however, the oxon degradate of other organophosphate (OP) pesticides have been reported equally or more toxic than parent. For example, the OP Cumulative Risk Assessment (OP CRA) reported methyl paraoxon and chlorpyriphos-oxon to be within 10-fold of the parent OP (USEPA, 2006c). In cases where there were no data on the relative potency of the oxon to the parent OP, the OP CRA used a 10x – 100x bracketing approach to characterize potential risk from exposure to the oxon (USEPA, 2006c). There have been only six detections of phosmet oxon at three sites in Merced County, CA all sampled in February 2004, but phosmet oxon was identified in only minor amounts in the environmental fate studies (≤0.5%) and its potential formation and decline in the environment is not characterized well enough to estimate environmental concentrations. Consequently, this assessment quantitatively consider effects resulting from exposures to phosmet parent only, but potential risk resulting from exposure to the oxon is discussed in the risk description.

There are no registered products that contain phosmet along with other active ingredients. Therefore, this analysis is based on the toxicity of the single active ingredient, phosmet.

2.3 Previous Assessments

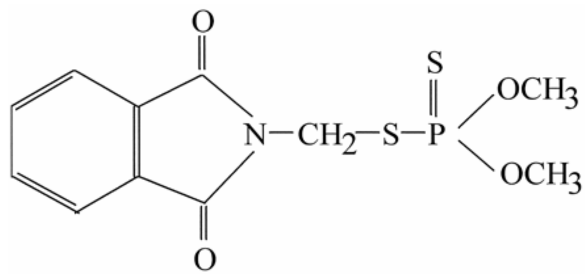
A Reregistration Eligibility Decision (RED) document was prepared for phosmet in 1998 (USEPA 1998). The RED identified potential acute and chronic risk to both aquatic and terrestrial animals from some use patterns. A 2001 Interim Reregistration Eligibility Decision (IRED) was issued which included some proposed risk mitigation measures, although the overall ecological risk conclusions did not change. In 2006, an assessment comparing current application rates to those previously assessed in support of the RED was conducted (USEPA 2006*b*). The assessment concluded that although label modifications (rate reductions for some uses and proposed cancellation of some uses) may have changed estimated environmental concentrations to some extent, they did not result in substantial changes to the overall risks estimated in the RED.

In 2003, the Agency released an endangered species assessment for Pacific salmonids (http://www.epa.gov/oppfead1/endanger/litstatus/effects/phosmet-analysis.pdf), which determined that the use of phosmet in accordance with label conditions will have no effect on 13 salmon and steelhead Evolutionarily Significant Units (ESUs) and that phosmet may affect, but is not likely to adversely affect 13 ESUs. These determinations were based on the known or potential use of phosmet on various use sites in each county where there is habitat or a migration corridor for an ESU, the acute risk of phosmet, and the expected bioavailability of phosmet.

2.4 Stressor Source and Distribution

2.4.1 Environmental Fate and Transport Assessment

Phosmet (N-(mercaptomethyl) phthalimide-S-(O,O-dimethyl phosphorodithioate) is a slightly mobile to moderately mobile chemical that is expected to dissipate quickly in the environment. In acidic soils where microbial activity is minimal, leaching may be a route of dissipation for the chemical. Phosmet is soluble in water (25 ppm, at 20^{o}C) and is not expected to volatilize significantly based on its low vapor pressure of 4.5×10^{-7} torr. There are no data on the bioaccumulation potential of phosmet in fish. However, the octanol/water partition coefficient ranges from 602 to 1096 suggesting low potential for bioaccumulation. General chemical properties of phosmet are summarized in **Table 2.1**.

Table 2.1 General Chemical Properties		
Parameter	**Value**	**Reference**
PC code	059201	
CAS No.	732-11-6	
Structure		
Chemical name	N-(Mercaptomethyl) phthalimide-S-(O,O-dimethyl phosphorodithioate	
Chemical formula	$C_{11}H_{12}NO_4PS_2$	
Molecular weight	317.3 g/mol	
Water solubility (20 °C)	25 mg/L	Product chemistry
Vapor pressure	4.5 $\times10^{-7}$ torr	Product chemistry
Henry's law constant	7.5 x 10^{-9} atm-m^3/mol	Calculated
Log K_{OW}	2.78-3.04	U.S. EPA 1998

Phosmet is subject to rapid hydrolysis under alkaline and neutral conditions and to a lesser degree under acidic conditions ($t_{1/2}$ = 3.8 x10^{-3}, 3.9 x10^{-1}, 7.5 d at pH 9, 7 and 5, respectively). Microbial-mediated degradation may also be a route of dissipation. Phosmet degrades ($t_{1/2}$ = 27 d, observed DT_{50} = 3-7 d, pH 7.4) under aerobic conditions in soil, and under anaerobic conditions ($t_{1/2}$ = 22 d, observed DT_{50} = 3-10 d, pH 7.1). Since phosmet hydrolyzes at neutral to alkaline pHs, these soil half-lives are reflective of both chemical hydrolysis as well as microbial degradation.

Phosmet is slightly to moderately mobile in soils, with Freundlich adsorption coefficients (K_f) that range from 1.17 to 15.8 ml/g (K_{oc} = 716 - 10,400 ml/g_{oc}) for four soils. Adsorption to these four soils is weakly correlated to organic carbon content and cation exchange capacity (CEC). There is more variability in the K_{oc} data than the K_f data. Phosmet was not detected below the 10.5-inch soil layer in any of three field dissipation studies and dissipated to, or below, the level of detection (LOD) prior to the study's completion. **Table 2.2** lists the environmental fate properties of phosmet, along with the major and minor degradates detected in the submitted environmental fate studies.

Phosmet oxon (O,O-dimethyl-S-phthalimido-methylphosphorothioate), the only known degradate of toxicological concern, was identified in very minor amounts (≤ 0.5%) in the environmental fate studies. In one field study phosmet oxon was detected in minor amounts (0.06 ppm) and limited to the upper soil layer. In aerobic and anaerobic soil metabolism studies, phosmet oxon was identified in small amounts relative to the parent and other degradates. The pattern of formation and decline of phosmet oxon is not characterized well enough to formulate a full fate assessment.

The only major degradate identified in the environmental fate studies was phthalamic acid which was identified at 34% of total residues at the termination of the hydrolysis study (day 11, pH 5). A number of other degradates were identified in the aerobic and anaerobic soil metabolism and hydrolysis studies. These degradates are various conjugates of the phthalimide, phthalamic acid, and phthalic acid moieties of the parent. No pattern of decline for the degradates was reported in the aerobic or anaerobic soil metabolism studies; therefore, their persistence relative to the parent is unclear. The degradates, N-methoxymethylphthalimide (maximum concentration 0.076 ppm immediately after 3rd app.) and phosmet oxon (maximum concentration 0.06 ppm on day 14 after final application), were identified in the field dissipation studies exclusively within the 0- to 3.5-inch soil layer. Phthalimide was not identified in the two field studies in which it was monitored.

Table 2.2 Summary of Phosmet Environmental Fate and Transport Properties				
Study	**Value (units)**	**Major Degradates (Minor Degradates)**	**MRID #**	**Study Status**
Hydrolysis	pH 5: $t_{1/2}$ = 7.5 d pH 7: $t_{1/2}$ = 3.9 x 10^{-1} d pH 9: $t_{1/2}$ = 3.8 x 10^{-3} d	pthalamic acid, (phthalic acid, phthalimide)	40394301	Acceptable
Aqueous Photolysis	Stable	--	42607901	Acceptable
Soil Photolysis	Stable	--	40759801	Acceptable
Aerobic Soil Metabolism	$t_{1/2}$ = 27 d; DT_{50} = 3-7 d (loam)	(phosmet oxon, pthalamic acid, n-hydroxymethyl phthalamic acid, pthalimide, n-methoxymethl pthalimide)	00112304 41497801	Acceptable
Anaerobic Soil Metabolism	$t_{1/2}$ = 22 d; DT_{50} = 3-10 d (loam)	(phosmet oxon, pthalamic acid, n-hydroxymethyl phthalamic acid, pthalimide, n-methoxymethl pthalimide)	01671807 41497801	Acceptable
Anaerobic Aquatic Metabolism	No data	--	--	--
Aerobic Aquatic Metabolism	No data	--	--	--
Freundlich K_{ads} (mL/g), $K_{oc\text{- }ads}$ (mL/g_{oc})	12.4 (1/n = 0.966), 10400 mL/g_{oc} (sandy loam) 1.17 (1/n = 0.978), 975 mL/g_{oc} (sand) 13.6 (1/n = 0.929), 757 mL/g_{oc} (loam) 15.8 (1/n = 0.892), 716 mL/g_{oc} (silt loam)	--	40599002	Acceptable
Terrestrial Field Dissipation	Foster fine sandy loam (CA): $t_{1/2}$ = 5 d (0-7 in) Bosket fine sandy loam (MS): $t_{1/2}$ = 8 d (0-7 in) California loam soil: $t_{1/2}$ =19 d (0-3 in)	(phosmet oxon, n-methoxymethyl phthalimide)	41464901 41464902 40599003	Acceptable

2.4.2 Environmental Transport Mechanisms

In general, potential transport mechanisms include pesticide surface water runoff (both dissolved and sediment-bound fractions), spray drift, and secondary drift of volatilized or soil-bound residues leading to deposition onto nearby or more distant ecosystems.

Secondary drift of phosmet is not expected to significantly occur due to the compound's water solubility and relatively low vapor pressure (*i.e.* phosmet is not volatile). Surface water runoff and spray drift are expected to be the major routes of transport in the environment for the compound.

2.4.3 Mechanism of Action

Phosmet is an organophosphate insecticide which inhibits the acetylcholinesterase enzyme essential for post-synaptic neuroimpulse transmission in cholinergic neurons.

2.4.4 Use Characterization

Analysis of labeled use information is the critical first step in evaluating the federal action. The current labels for phosmet represent the FIFRA regulatory action; therefore, labeled uses and application rates specified on the labels form the basis of this assessment. The assessment of use information is critical to the development of the action area and selection of appropriate modeling scenarios and inputs.

Current labels allow use of phosmet on alfalfa, orchard crops (*e.g.* almonds, walnuts, apples, and cherries), blueberries, citrus, cotton, grapes, Christmas trees, potatoes and truck vegetables. **Table 2.3** presents the uses and corresponding application rates considered in this assessment. In cases where application parameters are not explicitly prescribed on the labels, reasonable conservative assumptions were employed. For instance, alfalfa crops are labeled for use once per cutting, but no annual maximum is on the label. For this assessment, nine cuttings per year were assumed based on information provided by the Biological and Economic Analysis Division (BEAD) which identifies the maximum number of alfalfa cuttings in California to be nine.

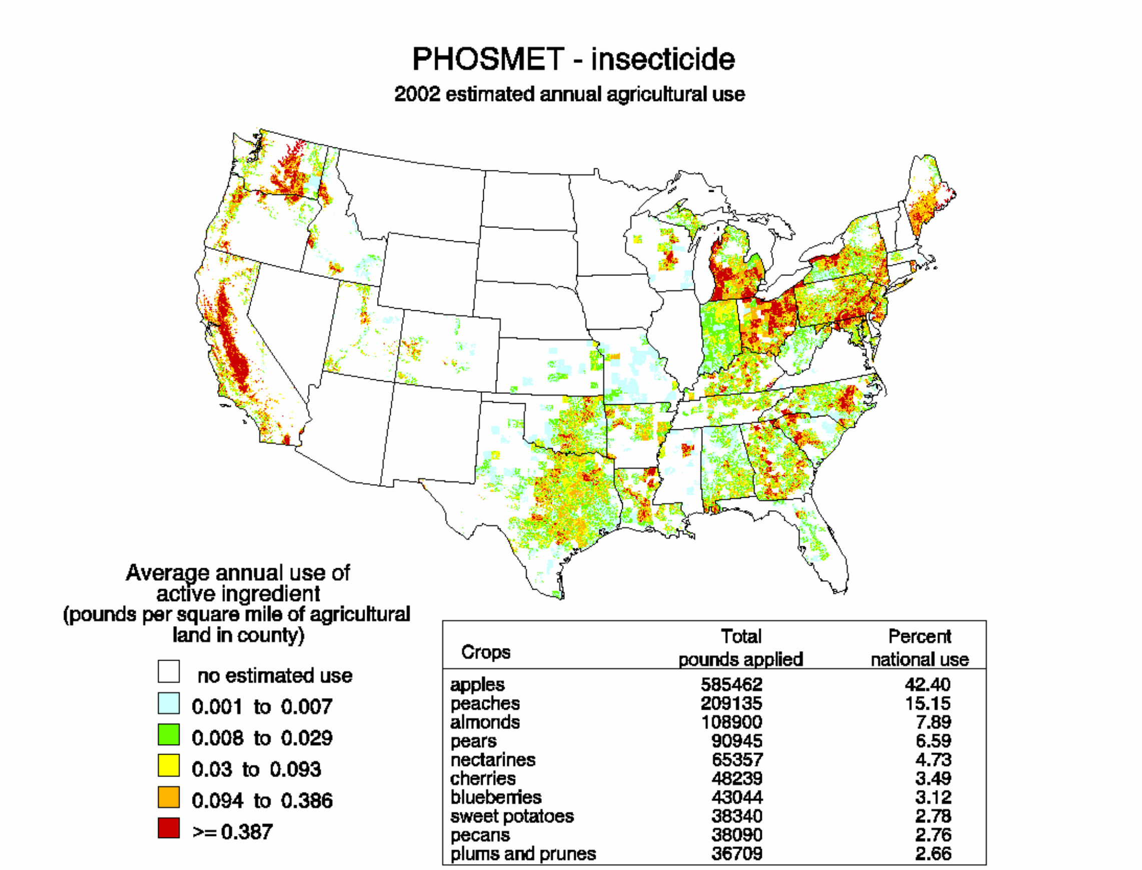
There is a nursery and ornamental tree plantings use allowed for phosmet. Due to appreciable differences from agricultural and forestry in label language, application methods and limitations in the Agency's standard evaluation methodologies, this use is being addressed qualitatively in the Risk Description , Section 5.3 of this document.

There are a number of mitigation measures relating to use sites, application rates or application intervals from the 2001 IRED that have yet to be implemented. These mitigation measures are pending and labels reflecting them are expected to be approved by the Registration Division before the end of the 2008 calendar year. These changes include cancelling cotton and citrus uses, and limiting the maximum seasonal application rates for orchard crops, grapes and forestry uses. For this assessment, maximum use patterns allowed on all current (as of June 2008) labels are assessed. The pending mitigation measures are detailed in **Appendix A**. While the expected mitigation measures would appreciably reduce some of the highest EECs, they are not expected to affect the overall risk picture or the resulting effects determination.

Table 2.3 Phosmet Maximum Use Patterns in the CRLF Action Area					
Use(s)	**Max. Single App. Rate (lbs a.i./A)**	**Number of App. per Year**	**Annual App. Rate (lbs a.i./A)**	**App. Interval (days)**	**App. Method**
Alfalfa	1.0 (per cutting)	9 (assuming 9 cuttings per year)	9.0	NS[1] (30 assumed)	Aerial, ground, chemigation
Almonds, walnuts, filberts, other tree nuts, pecans, pistachios	5.95	2	11.9	NS (5 assumed)	Aerial, ground, airblast
Citrus[2]	2.1	2	4.2	NS (5 assumed)	Aerial, ground, airblast
Cotton[2]	1.0	10	10	3	Aerial, ground
Apples, Apricots, crab apples nectarines, peaches, pears, cherries, plums, prunes [3]	5.0	NS (assumed 26)	NS	NS (5 assumed)	Aerial, ground, airblast
Grapes[4]	1.5	NS (assumed 26)	NS	NS (5 assumed)	Aerial, ground
Christmas Tree, Conifer trees, deciduous trees[5]	1.0	NS (assumed 26)	NS	NS (5 assumed)	Aerial, ground, airblast
Potato, sweet potato	0.9	5	4.5	10	Aerial, ground, chemigation
Peas	1.0	3	3.0	NS (5 assumed)	Aerial, ground
Blueberries	1.0	5	5.0	NS (5 assumed)	Aerial, ground

1. NS – not specified
2 These uses will be deleted when the mitigated labels are stamped.
3. The maximum use pattern for this group is based on pears (10163-175). The mitigated rate will limit the number of applications per year..
4. The mitigated label will limit the maximum seasonal application rate.
5. The mitigated label will limit the number of application per year.

Figure 2.1 presents the national usage pattern of phosmet in 2002. Usage was concentrated in California, the Pacific Northwest, the Midwest, and in portions of the eastern and southeastern United States. Orchard uses dominated the use patterns at that time with apples accounting for an estimated 42% and peaches, almonds, pears, nectarines and cherries combined accounting for an additional estimated 38% of phosmet usage (USGS 2007).



Crops	Total pounds applied	Percent national use
apples	585462	42.40
peaches	209135	15.15
almonds	108900	7.89
pears	90945	6.59
nectarines	65357	4.73
cherries	48239	3.49
blueberries	43044	3.12
sweet potatoes	38340	2.78
pecans	38090	2.76
plums and prunes	36709	2.66

Figure 2.1 National Phosmet Usage in 2002 (USGS 2007)

The Agency's Biological and Economic Analysis Division (BEAD) provides an analysis of both national- and county-level usage information (LaCapra and Gebkin 2007) using state-level usage data obtained from the U. S. Department of Agriculture (USDA) National Agricultural Statistics Service (NASS)[2], Doane (www.doane.com; the full dataset is not provided due to its proprietary nature) and the California's Department of Pesticide Regulation (CDPR) Pesticide Use Reporting (PUR) database[3]. CDPR PUR is considered a more comprehensive source of usage data than USDA NASS or proprietary databases, and thus the usage data reported for phosmet by county in this California-specific assessment were generated using CDPR PUR data. Four years (2002-2005) of usage data were included in this analysis. Data from CDPR PUR were obtained for every pesticide application made on every use site at the section level (approximately one square mile) of the public land survey system. BEAD summarized these data to the county level by site, pesticide, and unit treated. Calculating county-level usage involved summarizing across all applications made within a section and then across all sections within a county for each use site and for each pesticide. The county level usage data that

[2] United States Department of Agriculture (USDA), National Agricultural Statistics Service (NASS) Chemical Use Reports provide summary pesticide usage statistics for select agricultural use sites by chemical, crop and state. See http://www.usda.gov/nass/pubs/estindx1.htm#agchem.

[3] The California Department of Pesticide Regulation's (CDPR) Pesticide Use Reporting (PUR) database provides a census of pesticide applications in the state. See http://www.cdpr.ca.gov/docs/pur/purmain.htm.

were calculated include: average annual pounds applied, average annual area treated, and average and maximum application rate across all four years.

A summary of phosmet usage for all California use sites based on CDPR PUR data is provided below in **Table 2.4**. The highest average annual usage in California include almond (11,612 lbs) and pistachio (8,893 lbs). These use sites are followed by nectarine (2,939 lbs), peach (2,654 lbs) and plum (1,800 lbs). Phosmet is primarily applied by commercial applicators. Because commercial applicators are required to report their usage, these data are believed to be of high quality; the number of records reported for each site is likely to reflect the actual number of commercial uses on that site in California from 2002 to 2005. Further details are in **Appendix B**.

Table 2.4 Summary of California Department of Pesticide Registration (CDPR) Pesticide Use Reporting (PUR) Data from 2002 to 2005 for Currently Registered Phosmet Uses

Site Name	Avg Annual Application (lbs a.i.)	Avg App Rate (lbs a.i./A)	95th %-ile App Rate (lbs a.i./A)	99th %-ile App Rate (lbs a.i./A)	Max App Rate (lbs a.i./A)
Alfalfa	264.37	0.66	0.69	0.73	0.73
Almond	11,611.87	2.56	3.16	3.56	3.87
Apple	1,108.55	2.19	2.91	3.33	4.55
Apricot	117.46	1.84	2.18	2.31	2.31
Cherry	21.69	1.80	2.30	2.30	2.30
Christmas Tree	5.25	1.05	1.05	1.05	1.05
Citrus	0.18	0.70	0.70	0.70	0.70
Grape	291.26	1.15	1.59	2.56	2.76
Grape, Wine	113.91	1.57	2.06	2.75	2.75
Kiwi	2.91	1.39	1.88	1.88	1.88
Landscape Maintenance	1.86	0.11	0.14	0.14	0.14
Lemon	7.00	4.00	5.00	5.00	5.00
Nectarine	2,938.78	2.18	3.97	4.17	7.26
N-Outdr Flower	8.06	0.71	1.07	1.23	1.23
N-Outdr Plants In Containers	15.57	1.68	3.07	3.52	3.52
N-Outdr Transplants	3.50	3.11	3.11	3.11	3.11
Orange	1.88	1.50	1.50	1.50	1.50
Peach	2,653.99	2.22	2.89	3.14	6.32
Pear	672.07	3.08	5.40	5.55	5.62
Pecan	3.88	1.17	1.22	1.22	1.22
Pistachio	8,893.36	3.67	3.86	8.86	12.50
Plum	1,800.36	2.00	2.28	2.33	6.45
Prune	75.97	2.46	2.85	2.85	2.85
Stone Fruit	73.50	2.10	2.80	2.80	2.80
Uncultivated Ag	5.00	2.00	2.00	2.00	2.00
Walnut	1,850.37	3.09	4.71	4.96	6.84

Table 2.4 Summary of California Department of Pesticide Registration (CDPR) Pesticide Use Reporting (PUR) Data from 2002 to 2005 for Currently Registered Phosmet Uses					
Site Name	Avg Annual Application (lbs a.i.)	Avg App Rate (lbs a.i./A)	95^{th} %-ile App Rate (lbs a.i./A)	99^{th} %-ile App Rate (lbs a.i./A)	Max App Rate (lbs a.i./A)
Total	1,659.39	2.12	2.99	3.38	4.50

2.5 Assessed Species

The CRLF was federally listed as a threatened species by USFWS effective June 24, 1996 (USFWS 1996). It is one of two subspecies of the red-legged frog and is the largest native frog in the western United States (USFWS 2002). A brief summary of information regarding CRLF distribution, reproduction, diet, and habitat requirements is provided in Sections 2.5.1 through 2.5.4, respectively. Further information on the status, distribution, and life history of and specific threats to the CRLF is provided in Attachment 1.

Final critical habitat for the CRLF was designated by USFWS on April 13, 2006 (USFWS 2006; 71 FR 19244-19346). Further information on designated critical habitat for the CRLF is provided in Section 2.6.

2.5.1 Distribution

The CRLF is endemic to California and Baja California (Mexico) and historically inhabited 46 counties in California including the Central Valley and both coastal and interior mountain ranges (USFWS 1996). Its range has been reduced by about 70%, and the species currently resides in 22 counties in California (USFWS 1996). The species has an elevational range of near sea level to 1,500 meters (5,200 feet) (Jennings and Hayes, 1994); however, nearly all of the known CRLF populations have been documented below 1,050 meters (3,500 feet) (USFWS 2002).

Populations currently exist along the northern California coast, northern Transverse Ranges (USFWS 2002), foothills of the Sierra Nevada (5-6 populations), and in southern California south of Santa Barbara (two populations) (Fellers, 2005a). Relatively larger numbers of CRLFs are located between Marin and Santa Barbara Counties (Jennings and Hayes, 1994). A total of 243 streams or drainages are believed to be currently occupied by the species, with the greatest numbers in Monterey, San Luis Obispo, and Santa Barbara counties (USFWS 1996). Occupied drainages or watersheds include all bodies of water that support CRLFs (*i.e.*, streams, creeks, tributaries, associated natural and artificial ponds, and adjacent drainages), and habitats through which CRLFs can move (*i.e.*, riparian vegetation, uplands) (USFWS 2002).

The distribution of CRLFs within California is addressed in this assessment using four categories of location including recovery units, core areas, designated critical habitat, and known occurrences of the CRLF reported in the California Natural Diversity Database (CNDDB) that are not included within core areas and/or designated critical habitat (see

Figure 2.2). Recovery units, core areas, and other known occurrences of the CRLF from the CNDDB are described in further detail in this section, and designated critical habitat is addressed in Section 2.6. Recovery units are large areas defined at the watershed level that have similar conservation needs and management strategies. The recovery unit is primarily an administrative designation, and land area within the recovery unit boundary is not exclusively CRLF habitat. Core areas are smaller areas within the recovery units that comprise portions of the species' historic and current range and have been determined by USFWS to be important in the preservation of the species. Designated critical habitat is generally contained within the core areas, although a number of critical habitat units are outside the boundaries of core areas, but within the boundaries of the recovery units. Additional information on CRLF occurrences from the CNDDB is used to cover the current range of the species not included in core areas and/or designated critical habitat, but within the recovery units.

Recovery Units

Eight recovery units have been established by USFWS for the CRLF. These areas are considered essential to the recovery of the species, and the status of the CRLF "may be considered within the smaller scale of the recovery units, as opposed to the statewide range" (USFWS 2002). Recovery units reflect areas with similar conservation needs and population statuses, and therefore, similar recovery goals. The eight units described for the CRLF are delineated by watershed boundaries defined by US Geological Survey hydrologic units and are limited to the elevational maximum for the species of 1,500 m above sea level. The eight recovery units for the CRLF are listed in **Table 2.5** and shown in **Figure 2.2**.

Core Areas

USFWS has designated 35 core areas across the eight recovery units to focus their recovery efforts for the CRLF (see **Figure 2.2**). **Table 2.5** summarizes the geographical relationship among recovery units, core areas, and designated critical habitat. The core areas, which are distributed throughout portions of the historic and current range of the species, represent areas that allow for long-term viability of existing populations and reestablishment of populations within historic range. These areas were selected because they: 1) contain existing viable populations; or 2) they contribute to the connectivity of other habitat areas (USFWS 2002). Core area protection and enhancement are vital for maintenance and expansion of the CRLF's distribution and population throughout its range.

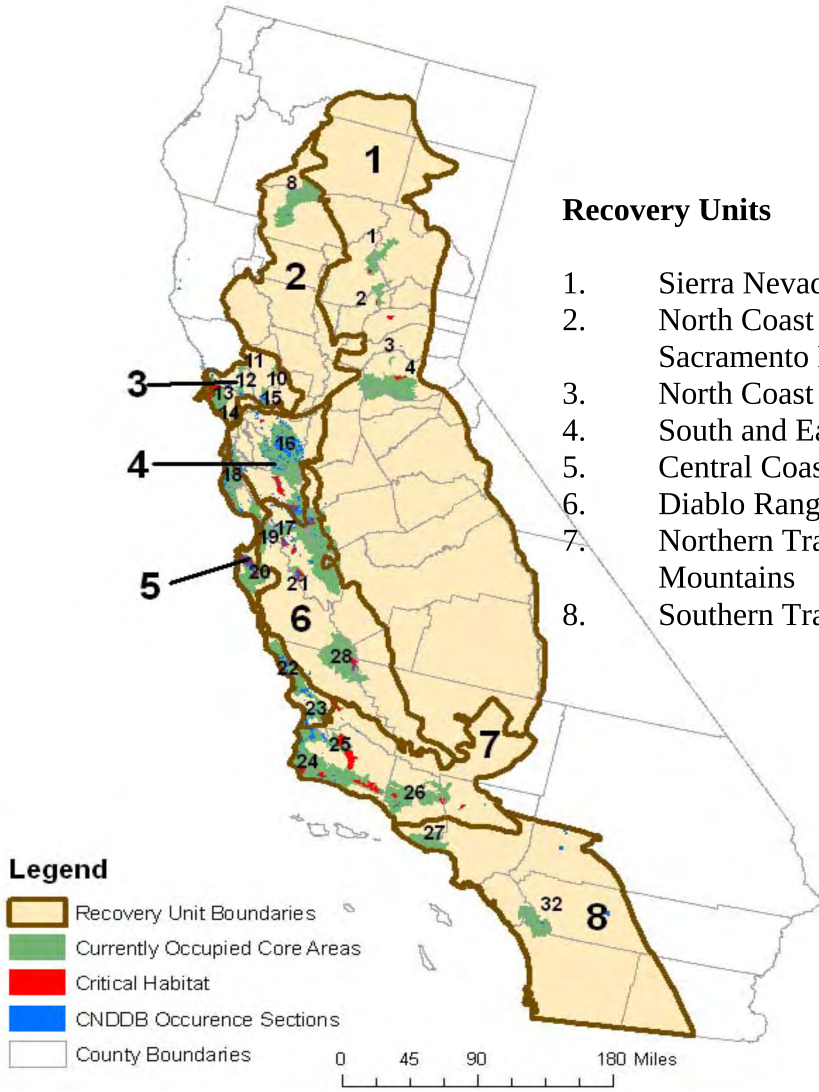
For purposes of this assessment, designated critical habitat, currently occupied (post-1985) core areas, and additional known occurrences of the CRLF from the CNDDB are considered. Each type of locational information is evaluated within the broader context of recovery units. For example, if no labeled uses of phosmet occur (or if labeled uses occur at predicted exposures less than the Agency's LOCs) within an entire recovery unit, a "no effect" determination would be made for all designated critical habitat, currently occupied core areas, and other known CNDDB occurrences within that recovery unit.

Historically occupied sections of the core areas are not evaluated as part of this assessment because the USFWS Recovery Plan (USFWS 2002) indicates that CRLFs are extirpated from these areas. A summary of currently and historically occupied core areas is provided in **Table 2.5** (currently occupied core areas are bolded). While core areas are considered essential for recovery of the CRLF, core areas are not federally-designated critical habitat, although designated critical habitat is generally contained within these core recovery areas. It should be noted, however, that several critical habitat units are located outside of the core areas, but within the recovery units. The focus of this assessment is currently occupied core areas, designated critical habitat, and other known CNDDB CRLF occurrences within the recovery units. Federally-designated critical habitat for the CRLF is further explained in Section 2.6.

Table 2.5 California Red-legged Frog Recovery Units with Overlapping Core Areas and Designated Critical Habitat				
Recovery Unit [1] (Figure 2.a)	**Core Areas [2,7] (Figure 2.a)**	**Critical Habitat Units [3]**	**Currently Occupied (post-1985) [4]**	**Historically Occupied [4]**
Sierra Nevada Foothills and Central Valley (1) (eastern boundary is the 1,500m elevation line)	**Cottonwood Creek (partial) (8)**	--	✓	
	Feather River (1)	BUT-1A-B	✓	
	Yuba River-S. Fork Feather River (2)	YUB-1	✓	
	--	NEV-1[6]		
	Traverse Creek/Middle Fork American River/Rubicon (3)	--	✓	
	Consumnes River (4)	ELD-1	✓	
	S. Fork Calaveras River (5)	--		✓
	Tuolumne River (6)	--		✓
	Piney Creek (7)	--		✓
	East San Francisco Bay (partial)(16)	--	✓	
North Coast Range Foothills and Western Sacramento River Valley (2)	**Cottonwood Creek (8)**	--	✓	
	Putah Creek-Cache Creek (9)	--		✓
	Jameson Canyon – Lower Napa Valley (partial) (15)	--	✓	
	Belvedere Lagoon (partial) (14)	--	✓	
	Pt. Reyes Peninsula (partial) (13)	--	✓	
North Coast and North San Francisco Bay (3)	Putah Creek-Cache Creek (partial) (9)	--		✓
	Lake Berryessa Tributaries (10)	NAP-1	✓	
	Upper Sonoma Creek (11)	--	✓	
	Petaluma Creek-Sonoma Creek (12)	--	✓	
	Pt. Reyes Peninsula (13)	MRN-1, MRN-2	✓	
	Belvedere Lagoon (14)	--	✓	
	Jameson Canyon-Lower Napa River (15)	SOL-1	✓	
South and East San Francisco Bay (4)	--	CCS-1A[6]		
	East San Francisco Bay (partial) (16)	ALA-1A, ALA-1B, STC-1B	✓	
	--	STC-1A[6]		
	South San Francisco Bay (partial) (18)	SNM-1A	✓	
Central Coast (5)	**South San Francisco Bay (partial) (18)**	SNM-1A, SNM-2C, SCZ-1	✓	
	Watsonville Slough- Elkhorn Slough (partial) (19)	SCZ-2 [5]	✓	
	Carmel River-Santa Lucia (20)	MNT-2	✓	
	Estero Bay (22)	--	✓	

Table 2.5 California Red-legged Frog Recovery Units with Overlapping Core Areas and Designated Critical Habitat				
Recovery Unit [1] (Figure 2.a)	**Core Areas [2,7] (Figure 2.a)**	**Critical Habitat Units [3]**	**Currently Occupied (post-1985) [4]**	**Historically Occupied [4]**
	--	SLO-8[6]		
	Arroyo Grande Creek (23)	--	✓	
	Santa Maria River-Santa Ynez River (24)	--	✓	
Diablo Range and Salinas Valley (6)	**East San Francisco Bay (partial) (16)**	MER-1A-B, STC-1B	✓	
	--	SNB-1[6], SNB-2[6]		
	Santa Clara Valley (17)	--	✓	
	Watsonville Slough- Elkhorn Slough (partial)(19)	MNT-1	✓	
	Carmel River-Santa Lucia (partial)(20)	--	✓	
	Gablan Range (21)	SNB-3	✓	
	Estrella River (28)	SLO-1A-B	✓	
Northern Transverse Ranges and Tehachapi Mountains (7)	--	SLO-8[6]		
	Santa Maria River-Santa Ynez River (24)	STB-4, STB-5, STB-7	✓	
	Sisquoc River (25)	STB-1, STB-3	✓	
	Ventura River-Santa Clara River (26)	VEN-1, VEN-2, VEN-3	✓	
	--	LOS-1[6]		
Southern Transverse and Peninsular Ranges (8)	**Santa Monica Bay-Ventura Coastal Streams (27)**	--	✓	
	San Gabriel Mountain (29)	--		✓
	Forks of the Mojave (30)	--		✓
	Santa Ana Mountain (31)	--		✓
	Santa Rosa Plateau (32)	--	✓	
	San Luis Rey (33)	--		✓
	Sweetwater (34)	--		✓
	Laguna Mountain (35)	--		✓

[1] Recovery units designated by the USFWS (USFWS 2000, pg 49).
[2] Core areas designated by the USFWS (USFWS 2000, pg 51).
[3] Critical habitat units designated by the USFWS on April 13, 2006 (USFWS 2006; 71 FR 19244-19346).
[4] Currently occupied (post-1985) and historically occupied core areas as designated by the USFWS (USFWS 2002, pg 54).
[5] Critical habitat unit where identified threats specifically included pesticides or agricultural runoff (USFWS 2002).
[6] Critical habitat units that are outside of core areas, but within recovery units.
[7] Currently occupied core areas that are included in this effects determination are bolded.



Recovery Units

1. Sierra Nevada Foothills and Central Valley
2. North Coast Range Foothills and Western Sacramento River Valley
3. North Coast and North San Francisco Bay
4. South and East San Francisco Bay
5. Central Coast
6. Diablo Range and Salinas Valley
7. Northern Transverse Ranges and Tehachapi Mountains
8. Southern Transverse and Peninsular Ranges

Figure 2.2 Recovery Unit, Core Area, Critical Habitat, and Occurrence Designations for CRLF

Core Areas

1. Feather River
2. Yuba River- S. Fork Feather River
3. Traverse Creek/ Middle Fork/ American R. Rubicon
4. Cosumnes River
5. South Fork Calaveras River*
6. Tuolumne River*
7. Piney Creek*
8. Cottonwood Creek
9. Putah Creek – Cache Creek*
10. Lake Berryessa Tributaries
11. Upper Sonoma Creek
12. Petaluma Creek – Sonoma Creek
13. Pt. Reyes Peninsula
14. Belvedere Lagoon
15. Jameson Canyon – Lower Napa River
16. East San Francisco Bay
17. Santa Clara Valley
18. South San Francisco Bay
19. Watsonville Slough-Elkhorn Slough
20. Carmel River – Santa Lucia
21. Gablan Range
22. Estero Bay
23. Arroyo Grange River
24. Santa Maria River – Santa Ynez River
25. Sisquoc River
26. Ventura River – Santa Clara River
27. Santa Monica Bay – Venura Coastal Streams
28. Estrella River
29. San Gabriel Mountain*
30. Forks of the Mojave*
31. Santa Ana Mountain*
32. Santa Rosa Plateau
33. San Luis Ray*
34. Sweetwater*
35. Laguna Mountain*

* Core areas that were historically occupied by the California red-legged frog are not included in the map

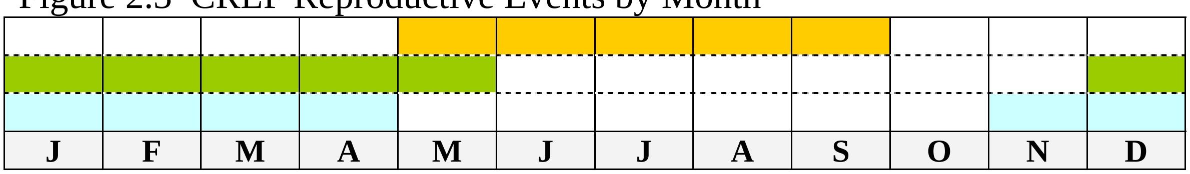
Other Known Occurrences from the CNDBB

The CNDDB provides location and natural history information on species found in California. The CNDDB serves as a repository for historical and current species location sightings. Information regarding known occurrences of CRLFs outside of the currently occupied core areas and designated critical habitat is considered in defining the current range of the CRLF. See: http://www.dfg.ca.gov/bdb/html/cnddb_info.html for additional information on the CNDDB.

2.5.2 Reproduction

CRLFs breed primarily in ponds; however, they may also breed in quiescent streams, marshes, and lagoons (Fellers 2005a). According to the Recovery Plan (USFWS 2002), CRLFs breed from November through late April. Peaks in spawning activity vary geographically; Fellers (2005b) reports peak spawning as early as January in parts of coastal central California. Eggs are fertilized as they are being laid. Egg masses are typically attached to emergent vegetation, such as bulrushes (*Scirpus* spp.) and cattails (*Typha* spp.) or roots and twigs, and float on or near the surface of the water (Hayes and Miyamoto 1984). Egg masses contain approximately 2000 to 6000 eggs ranging in size between 2 and 2.8 mm (Jennings and Hayes 1994). Embryos hatch 10 to 14 days after fertilization (Fellers 2005a) depending on water temperature. Egg predation is reported to be infrequent and most mortality is associated with the larval stage (particularly through predation by fish); however, predation on eggs by newts has also been reported (Rathburn 1998). Tadpoles require 11 to 28 weeks to metamorphose into juveniles (terrestrial-phase), typically between May and September (Jennings and Hayes 1994, USFWS 2002); tadpoles have been observed to over-winter (delay metamorphosis until the following year) (Fellers 2005b; USFWS 2002). Males reach sexual maturity at 2 years, and females reach sexual maturity at 3 years of age; adults have been reported to live 8 to 10 years (USFWS 2002). **Figure 2.3** depicts CRLF annual reproductive timing.

Figure 2.3 CRLF Reproductive Events by Month



Light Blue = **Breeding/Egg Masses**
Green = **Tadpoles (except those that over-winter)**
Orange = **Young Juveniles**
Adults and juveniles can be present all year

2.5.3 Diet

Although the diet of CRLF aquatic-phase larvae (tadpoles) has not been studied specifically, it is assumed that their diet is similar to that of other frog species, with the aquatic phase feeding exclusively in water and consuming diatoms, algae, and detritus (USFWS 2002). Tadpoles filter and entrap suspended algae (Seale and Beckvar 1980) via mouthparts designed for effective grazing of periphyton (Wassersug 1984; Kupferberg *et al.* 1994; Kupferberg 1997; Altig and McDiarmid 1999).

Juvenile and adult CRLFs forage in aquatic and terrestrial habitats, and their diet differs greatly from that of larvae. The main food source for juvenile aquatic- and terrestrial-phase CRLFs is thought to be aquatic and terrestrial invertebrates found along the shoreline and on the water surface. Hayes and Tennant (1985) report, based on a study examining the gut content of 35 juvenile and adult CRLFs, that the species feeds on as many as 42 different invertebrate taxa, including Arachnida, Amphipoda, Isopoda, Insecta, and Mollusca. The most commonly observed prey species were larval alderflies (*Sialis* cf. *californica*), pillbugs (*Armadilliadrium vulgare*), and water striders (*Gerris* sp). The preferred prey species, however, was the sowbug (Hayes and Tennant 1985). This study suggests that CRLFs forage primarily above water, although the authors note other data reporting that adults also feed under water, are cannibalistic, and consume fish. For larger CRLFs, over 50% of the prey mass may consists of vertebrates such as mice, frogs, and fish, although aquatic and terrestrial invertebrates were the most numerous food items (Hayes and Tennant 1985). For adults, feeding activity takes place primarily at night; for juveniles feeding occurs during the day and at night (Hayes and Tennant 1985).

2.5.4 Habitat

CRLFs require aquatic habitat for breeding, but also use other habitat types including riparian and upland areas throughout their life cycle. CRLF use of their environment varies; they may complete their entire life cycle in a particular habitat or they may utilize multiple habitat types. Overall, populations are most likely to exist where multiple breeding areas are embedded within varying habitats used for dispersal (USFWS 2002). Generally, CRLFs utilize habitat with perennial or near-perennial water (Jennings *et al.* 1997). Dense vegetation close to water, shading, and water of moderate depth are habitat features that appear especially important for CRLF (Hayes and Jennings 1988).

Breeding sites include streams, deep pools, backwaters within streams and creeks, ponds, marshes, sag ponds (land depressions between fault zones that have filled with water), dune ponds, and lagoons. Breeding adults have been found near deep (0.7 m) still or slow moving water surrounded by dense vegetation (USFWS 2002); however, the largest number of tadpoles have been found in shallower pools (0.26 – 0.5 m) (Reis 1999). Data indicate that CRLFs do not frequently inhabit vernal pools, as conditions in these habitats generally are not suitable (Hayes and Jennings 1988).

CRLFs also frequently breed in artificial impoundments such as stock ponds, although additional research is needed to identify habitat requirements within artificial ponds (USFWS 2002). Adult CRLFs use dense, shrubby or emergent vegetation closely associated with deep-water pools bordered with cattails and dense stands of overhanging vegetation (http://www.fws.gov/endangered/features/rl_frog/rlfrog.html#where).

In general, dispersal and habitat use depends on climatic conditions, habitat suitability, and life stage. Adults rely on riparian vegetation for resting, feeding, and dispersal. The foraging quality of the riparian habitat depends on moisture, composition of the plant community, and presence of pools and backwater aquatic areas for breeding. CRLFs can be found living within streams at distances up to 3 km (2 miles) from their breeding site and have been found up to 30 m (100 feet) from water in dense riparian vegetation for up to 77 days (USFWS 2002).

During dry periods, the CRLF is rarely found far from water, although it will sometimes disperse from its breeding habitat to forage and seek other suitable habitat under downed trees or logs, industrial debris, and agricultural features (UWFWS 2002). According to Jennings and Hayes (1994), CRLFs also use small mammal burrows and moist leaf litter as habitat. In addition, CRLFs may also use large cracks in the bottom of dried ponds as refugia; these cracks may provide moisture for individuals avoiding predation and solar exposure (Alvarez 2000).

2.6 Designated Critical Habitat

In a final rule published on April 13, 2006, 34 separate units of critical habitat were designated for the CRLF by USFWS (USFWS 2006; FR 51 19244-19346). A summary of the 34 critical habitat units relative to USFWS-designated recovery units and core areas (previously discussed in Section 2.5.1) is provided in **Table 2.5**.

'Critical habitat' is defined in the ESA as the geographic area occupied by the species at the time of the listing where the physical and biological features necessary for the conservation of the species exist, and there is a need for special management to protect the listed species. It may also include areas outside the occupied area at the time of listing if such areas are 'essential to the conservation of the species.' All designated critical habitat for the CRLF was occupied at the time of listing. Critical habitat receives protection under Section 7 of the ESA through prohibition against destruction or adverse modification with regard to actions carried out, funded, or authorized by a federal Agency. Section 7 requires consultation on federal actions that are likely to result in the destruction or adverse modification of critical habitat.

To be included in a critical habitat designation, the habitat must be 'essential to the conservation of the species.' Critical habitat designations identify, to the extent known using the best scientific and commercial data available, habitat areas that provide essential life cycle needs of the species or areas that contain certain primary constituent elements (PCEs) (as defined in 50 CFR 414.12(b)). PCEs include, but are not limited to, space for individual and population growth and for normal behavior; food, water, air, light, minerals, or other nutritional or physiological requirements; cover or shelter; sites for breeding, reproduction, rearing (or development) of offspring; and habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species. The designated critical habitat areas for the CRLF are considered to have the following PCEs that justify critical habitat designation: breeding aquatic habitat, non-breeding aquatic habitat, upland habitat, and dispersal habitat. Further description of these habitat types is provided in **Attachment 1**.

Occupied habitat may be included in the critical habitat only if essential features within the habitat may require special management or protection. Therefore, USFWS does not include areas where existing management is sufficient to conserve the species. Critical habitat is designated outside the geographic area presently occupied by the species only when a designation limited to its present range would be inadequate to ensure the conservation of the species. For the CRLF, all designated critical habitat units contain all four of the PCEs, and were occupied by the CRLF at the time of FR listing notice in April 2006. The FR notice designating critical habitat for the CRLF includes a special rule exempting routine ranching activities associated with livestock ranching from incidental take prohibitions. The purpose of this exemption is to promote the conservation of rangelands, which could be beneficial to the CRLF, and to reduce the rate of conversion to other land uses that are incompatible with CRLF conservation. Please see Attachment 1 for a full explanation on this special rule.

USFWS has established adverse modification standards for designated critical habitat (USFWS 2006). Activities that may destroy or adversely modify critical habitat are those that alter the PCEs and jeopardize the continued existence of the species. Evaluation of actions related to use of phosmet that may alter the PCEs of the CRLF's critical habitat form the basis of the critical habitat impact analysis. According to USFWS (2006), activities that may affect critical habitat and therefore result in adverse effects to the CRLF include, but are not limited to the following:

(1) Significant alteration of water chemistry or temperature to levels beyond the tolerances of the CRLF that result in direct or cumulative adverse effects to individuals and their life-cycles.
(2) Significant increase in sediment deposition within the stream channel or pond or disturbance of upland foraging and dispersal habitat that could result in elimination or reduction of habitat necessary for the growth and reproduction of the CRLF by increasing the sediment deposition to levels that would adversely affect their ability to complete their life cycles.
(3) Significant alteration of channel/pond morphology or geometry that may lead to changes to the hydrologic functioning of the stream or pond and alter the timing, duration, water flows, and levels that would degrade or eliminate the CRLF and/or its habitat. Such an effect could also lead to increased sedimentation and degradation in water quality to levels that are beyond the CRLF's tolerances.
(4) Elimination of upland foraging and/or aestivating habitat or dispersal habitat.
(5) Introduction, spread, or augmentation of non-native aquatic species in stream segments or ponds used by the CRLF.
(6) Alteration or elimination of the CRLF's food sources or prey base (also evaluated as indirect effects to the CRLF).

As previously noted in Section 2.1, the Agency believes that the analysis of direct and indirect effects to listed species provides the basis for an analysis of potential effects on the designated critical habitat. Because phosmet is expected to directly impact living organisms within the action area, critical habitat analysis for phosmet is limited in a practical sense to those PCEs of critical habitat that are biological or that can be reasonably linked to biologically mediated processes.

2.7 Action Area

For listed species assessment purposes, the action area is considered to be the area affected directly or indirectly by the federal action and not merely the immediate area involved in the action (50 CFR 402.02). It is recognized that the overall action area for the national registration of phosmet is likely to encompass considerable portions of the United States based on its uses. However, the scope of this assessment limits consideration of the overall action area to those portions that may be applicable to the protection of the CRLF and its designated critical habitat within the state of California.

Deriving the geographical extent of this portion of the action area is based on consideration of the types of effects that phosmet may be expected to have on the environment, the exposure levels to phosmet that are associated with those effects, and the best available information concerning the use of phosmet and its fate and transport within the state of California. Specific measures of ecological effect for the CRLF that define the action area include any direct and indirect toxic effect to the CRLF and any potential modification of its critical habitat, including reduction in survival, growth, and fecundity as well as the full suite of sublethal effects available in the effects literature. Therefore, the action area extends to a point where environmental exposures are below any measured lethal or sublethal effect threshold for any biological entity at the whole organism, organ, tissue, and cellular level of organization. In situations where it is not possible to determine the threshold for an observed effect, the action area is not spatially limited and is assumed to be the entire state of California.

The definition of action area requires a stepwise approach that begins with an understanding of the federal action. The federal action is defined by the currently labeled uses for phosmet. An analysis of labeled uses and review of available product labels was completed. Several of the currently labeled uses are special local needs (SLN) uses or are restricted to specific states and are excluded from this assessment. In addition, a distinction has been made between food use crops and those that are non-food/non-agricultural uses. For those phosmet uses relevant to the CRLF, the analysis indicates that the following agricultural uses are considered as part of the federal action evaluated in this assessment:

- Alfalfa, blueberries, citrus, cotton, grapes, orchards (almonds, walnuts, filberts, pecans, pistachios, other tree nuts, apples, apricots, crab apples, nectarines, peaches, pears, cherries, plums, prunes), potatoes, sweet potatoes, peas.

In addition, the following non-food and non-agricultural uses are considered:

- Nursery (flowering trees, ornamental plants, non-bearing fruit trees, non-bearing nut trees) and forestry (Christmas tree, conifer trees, deciduous trees).

Following a determination of the assessed uses, an evaluation of the potential “footprint” of phosmet use patterns (*i.e.*, the area where pesticide application occurs) is determined. This “footprint” represents the initial area of concern, based on an analysis of available NLCD land cover data for the state of California. The initial area of concern is defined as all land cover types and the stream reaches within the land cover areas that represent the labeled uses described above. A map representing all the land cover types that make up the initial area of concern for phosmet is presented in **Figure 2.4**.

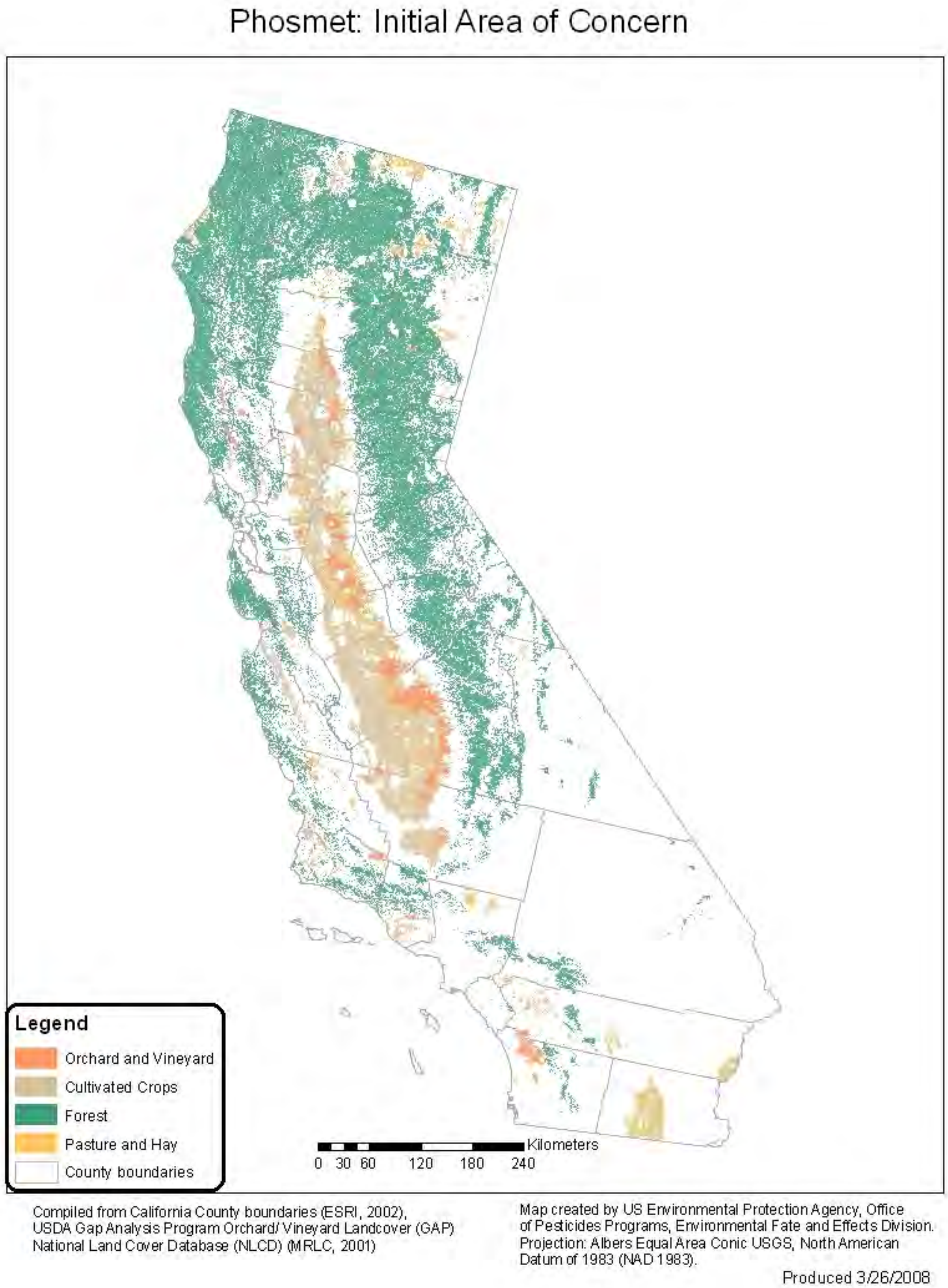


Figure 2.4 Initial area of concern, or "footprint" of potential use, for phosmet

Once the initial area of concern is defined, the next step is to define the potential boundaries of the action area by determining the extent of offsite transport via spray drift and runoff where exposure of one or more taxonomic groups to the pesticide exceeds the listed species LOCs.

As previously discussed, the action area is defined by the most sensitive measure of direct and indirect ecological toxic effects including reduction in survival, growth, reproduction, and the entire suite of sublethal effects from valid, peer-reviewed studies.

Due to positive results in several mutagenicity tests (MRIDs 00164884, 00164885, 00164888), phosmet has been identified as a potential mutagen. Since these tests are not designed to establish a NOAEC, the extent to which animals may be sensitive to this effect is unknown. Therefore, at this time it is not possible to estimate the full spatial extent to which phosmet could affect non-target organisms. As a result, it is assumed that the action area encompasses the entire state of California, regardless of the spatial extent (*i.e*., initial area of concern or footprint) of the pesticide application areas.

2.8 Assessment Endpoints and Measures of Ecological Effect

Assessment endpoints are defined as "explicit expressions of the actual environmental value that is to be protected."[4] Selection of the assessment endpoints is based on valued entities (*e.g.,* CRLF, organisms important in the life cycle of the CRLF, and the PCEs of its designated critical habitat), the ecosystems potentially at risk (*e.g.*, waterbodies, riparian vegetation, and upland and dispersal habitats), the migration pathways of phosmet (*e.g.,* runoff, spray drift, etc.), and the routes by which ecological receptors are exposed to phosmet *(e.g.,* direct contact, *etc.).*

2.8.1. Assessment Endpoints for the CRLF

Assessment endpoints for the CRLF include direct toxic effects on the survival, reproduction, and growth of the CRLF, as well as indirect effects, such as reduction of the prey base or modification of its habitat. In addition, potential modification of critical habitat is assessed by evaluating potential effects to PCEs, which are components of the habitat areas that provide essential life cycle needs of the CRLF. Each assessment endpoint requires one or more "measures of ecological effect," defined as changes in the attributes of an assessment endpoint or changes in a surrogate entity or attribute in response to exposure to a pesticide. Specific measures of ecological effect are generally evaluated based on acute and chronic toxicity information from registrant-submitted guideline tests that are performed on a limited number of organisms. Additional ecological effects data from the open literature are also considered.

A complete discussion of all the toxicity data available for this risk assessment, including resulting measures of ecological effect selected for each taxonomic group of concern, is included in Section 4 of this document. A summary of the assessment endpoints and measures of ecological effect selected to characterize potential assessed direct and indirect CRLF risks associated with exposure to phosmet is provided in **Table 2.7**.

[4] From U.S. EPA (1992). *Framework for Ecological Risk Assessment.* EPA/630/R-92/001.

Table 2.7 Assessment Endpoints and Measures of Ecological Effects	
Assessment Endpoint	**Measures of Ecological Effects**
Aquatic-Phase CRLF (Eggs, larvae, and adults)[a]	
Direct Effects	
1. Survival, growth, and reproduction of CRLF	1a. Most sensitive fish acute LC_{50} (guideline study) since no suitable amphibian data are available 1b. Estimated fish chronic NOAEC (based on freshwater invertebrate acute-to-chronic ratio)
Indirect Effects and Critical Habitat Effects	
2. Survival, growth, and reproduction of CRLF individuals via indirect effects on aquatic prey food supply (*i.e.*, fish, freshwater invertebrates, non-vascular plants)	2a. Most sensitive fish, aquatic invertebrate, and aquatic plant EC_{50} or LC_{50} (guideline studies) 2b. Most sensitive aquatic invertebrate and fish chronic NOAEC (fish NOAEC based on estimate using mammalian acute-to-chronic ratio)
3. Survival, growth, and reproduction of CRLF individuals via indirect effects on habitat, cover, food supply, and/or primary productivity (*i.e.*, aquatic plant community)	3a. Vascular plant acute EC_{50} (duckweed guideline test) 3b. Non-vascular plant acute EC_{50} (freshwater algae)
4. Survival, growth, and reproduction of CRLF individuals via effects to riparian vegetation	4a. Most sensitive EC_{25} values for monocots (guideline seedling emergence and vegetative vigor studies) 4b. Most sensitive EC_{25} values for dicots (guideline seedling emergence and vegetative vigor studies)
Terrestrial-Phase CRLF (Juveniles and adults)	
Direct Effects	
5. Survival, growth, and reproduction of CRLF individuals via direct effects on terrestrial phase adults and juveniles	5a. Most sensitive bird[b] acute LD_{50} (guideline study) 5b. Most sensitive bird[b] chronic NOAEC (estimated using mammalian acute-to-chronic ratio)
Indirect Effects and Critical Habitat Effects	
6. Survival, growth, and reproduction of CRLF individuals via effects on terrestrial prey (*i.e.*, terrestrial invertebrates, small mammals , and frogs)	6a. Most sensitive terrestrial invertebrate and vertebrate acute EC_{50} or LC_{50} (guideline studies) 6b. Most sensitive terrestrial invertebrate and vertebrate chronic NOAEC (guideline studies)
7. Survival, growth, and reproduction of CRLF individuals via indirect effects on habitat (*i.e.*, riparian and upland vegetation)	7a. Most sensitive EC_{25} for monocots (guideline seedling emergence and vegetative vigor studies) 7b. Most sensitive EC_{25} for dicots (guideline seedling emergence and vegetative vigor studies)

[a] Adult frogs are no longer in the "aquatic-phase" of the amphibian life cycle; however, submerged adult frogs are considered "aquatic" for the purposes of this assessment because exposure pathways in the water are considerably different that exposure pathways on land.
[b] Birds are used as surrogates for terrestrial-phase amphibians.

2.8.2 Assessment Endpoints for Designated Critical Habitat

As previously discussed, designated critical habitat is assessed to evaluate actions related to the use of phosmet that may alter the PCEs of the CRLF's critical habitat. PCEs for the CRLF were previously described in Section 2.6. Actions that may modify critical habitat are those that alter the PCEs and jeopardize the continued existence of the CRLF. Therefore, these actions are identified as assessment endpoints. It should be noted that evaluation of PCEs as assessment endpoints is limited to those of a biological nature (*i.e.*, the biological resource requirements for the listed species associated with the critical habitat) and those for which phosmet effects data are available.

Adverse modification to the critical habitat of the CRLF includes, but is not limited to, the following, as specified by USFWS (2006):

1. Alteration of water chemistry/quality including temperature, turbidity, and oxygen content necessary for normal growth and viability of juvenile and adult CRLFs.
2. Alteration of chemical characteristics necessary for normal growth and viability of juvenile and adult CRLFs.
3. Significant increase in sediment deposition within the stream channel or pond or disturbance of upland foraging and dispersal habitat.
4. Significant alteration of channel/pond morphology or geometry.
5. Elimination of upland foraging and/or aestivating habitat, as well as dispersal habitat.
6. Introduction, spread, or augmentation of non-native aquatic species in stream segments or ponds used by the CRLF.
7. Alteration or elimination of the CRLF's food sources or prey base.

Measures of such possible effects by labeled use of phosmet on critical habitat of the CRLF are described in **Table 2.8**. Some components of these PCEs are associated with physical abiotic features (*e.g.*, presence and/or depth of a water body, or distance between two sites), which are not expected to be measurably altered by use of pesticides. Assessment endpoints used for the analysis of designated critical habitat are based on the adverse modification standard established by USFWS (2006).

<table>
<tr><th colspan="2">Table 2.8 Summary of Assessment Endpoints and Measures of Ecological Effect for Primary Constituent Elements of Designated Critical Habitat[a]</th></tr>
<tr><th>Assessment Endpoint</th><th>Measures of Ecological Effect</th></tr>
<tr><td colspan="2">Aquatic-Phase CRLF PCEs
(Aquatic Breeding Habitat and Aquatic Non-Breeding Habitat)</td></tr>
<tr><td>Alteration of channel/pond morphology or geometry and/or increase in sediment deposition within the stream channel or pond: aquatic habitat (including riparian vegetation) provides for shelter, foraging, predator avoidance, and aquatic dispersal for juvenile and adult CRLFs.</td><td rowspan="2">a. Most sensitive EC_{50} values for aquatic plants (guideline studies)
b. Most sensitive EC_{25} values for terrestrial monocots (guideline seedling emergence and vegetative vigor studies)
c. Most sensitive EC_{25} values for terrestrial dicots (guideline seedling emergence and vegetative vigor studies)</td></tr>
<tr><td>Alteration in water chemistry/quality including temperature, turbidity, and oxygen content necessary for normal growth and viability of juvenile and adult CRLFs and their food source.</td></tr>
<tr><td>Alteration of other chemical characteristics necessary for normal growth and viability of CRLFs and their food source.</td><td>a. Most sensitive EC_{50} or LC_{50} values for fish and aquatic invertebrates (guideline studies)
b. Most sensitive NOAEC values for fish and aquatic invertebrates (guideline studies). Chronic NOAEC for fish based on estimate derived using mammalian acute-to-chronic ratio.</td></tr>
<tr><td>Reduction and/or modification of aquatic-based food sources for pre-metamorphs (e.g., algae)</td><td>a. Most sensitive aquatic plant EC_{50} (guideline study)</td></tr>
<tr><td colspan="2">Terrestrial-Phase CRLF PCEs
(Upland Habitat and Dispersal Habitat)</td></tr>
<tr><td>Elimination and/or disturbance of upland habitat; ability of habitat to support food source of CRLFs: Upland areas within 200 ft of the edge of the riparian vegetation or dripline surrounding aquatic and riparian habitat that are comprised of grasslands, woodlands, and/or wetland/riparian plant species that provides the CRLF shelter, forage, and predator avoidance</td><td rowspan="4">a. Most sensitive EC_{25} values for monocots (guideline seedling emergence and vegetative vigor studies)
b. Most sensitive EC_{25} values for dicots (guideline seedling emergence and vegetative vigor studies)
c. Most sensitive food source acute EC_{50}/LC_{50} and NOAEC values for terrestrial vertebrates (mammals) and invertebrates, birds, and freshwater fish. (NOAEC for birds and fish derived using mammalian acute-to-chronic ratio)</td></tr>
<tr><td>Elimination and/or disturbance of dispersal habitat: Upland or riparian dispersal habitat within designated units and between occupied locations within 0.7 mi of each other that allow for movement between sites including both natural and altered sites which do not contain barriers to dispersal</td></tr>
<tr><td>Reduction and/or modification of food sources for terrestrial phase juveniles and adults</td></tr>
<tr><td>Alteration of chemical characteristics necessary for normal growth and viability of juvenile and adult CRLFs and their food source.</td></tr>
</table>

[a] Physico-chemical water quality parameters such as salinity, pH, and hardness are not evaluated because these processes are not biologically mediated and, therefore, are not relevant to the endpoints included in this assessment.

2.9 Conceptual Model

2.9.1 Risk Hypotheses

Risk hypotheses are specific assumptions about potential adverse effects (*i.e.* deleterious changes in assessment endpoints) and may be based on theory and logic, empirical data, mathematical models, or probability models (USEPA 1998). For this assessment, the risk is stressor-linked, where the stressor is the release of phosmet to the environment. The following risk hypotheses are applied to this endangered species assessment:

The labeled use of phosmet within the action area may:

- directly affect the CRLF by causing mortality or by adversely affecting growth or fecundity;
- indirectly affect the CRLF by reducing or changing the composition of food supply;
- indirectly affect the CRLF or modify designated critical habitat by reducing or changing the composition of the aquatic plant community in the ponds and streams comprising the species' current range and designated critical habitat, thus affecting primary productivity and/or cover;
- indirectly affect the CRLF or modify designated critical habitat by reducing or changing the composition of the terrestrial plant community (*i.e.*, riparian habitat) required to maintain acceptable water quality and habitat in the ponds and streams comprising the species' current range and designated critical habitat;
- modify the designated critical habitat of the CRLF by reducing or changing breeding and non-breeding aquatic habitat (via modification of water quality parameters, habitat morphology, and/or sedimentation);
- modify the designated critical habitat of the CRLF by reducing the food supply required for normal growth and viability of juvenile and adult CRLFs;
- modify the designated critical habitat of the CRLF by reducing or changing upland habitat within 200 ft of the edge of the riparian vegetation necessary for shelter, foraging, and predator avoidance.
- modify the designated critical habitat of the CRLF by reducing or changing dispersal habitat within designated units and between occupied locations within 0.7 mi of each other that allow for movement between sites including both natural and altered sites which do not contain barriers to dispersal.
- modify the designated critical habitat of the CRLF by altering chemical characteristics necessary for normal growth and viability of juvenile and adult CRLFs.

2.9.2 Diagram

The conceptual model is a graphic representation of the structure of the risk assessment. It specifies the phosmet release mechanisms, biological receptor types, and effects endpoints of potential concern. The conceptual models for aquatic and terrestrial phases of the CRLF are shown in **Figures 2.9 and 2.10**, respectively, and the conceptual models for the aquatic and terrestrial PCE components of critical habitat are shown in **Figures 2.11 and 2.12**, respectively. Exposure routes shown in dashed lines are not quantitatively considered because the contribution of those potential exposure routes to potential risks to the CRLF and modification to designated critical habitat is expected to be negligible.

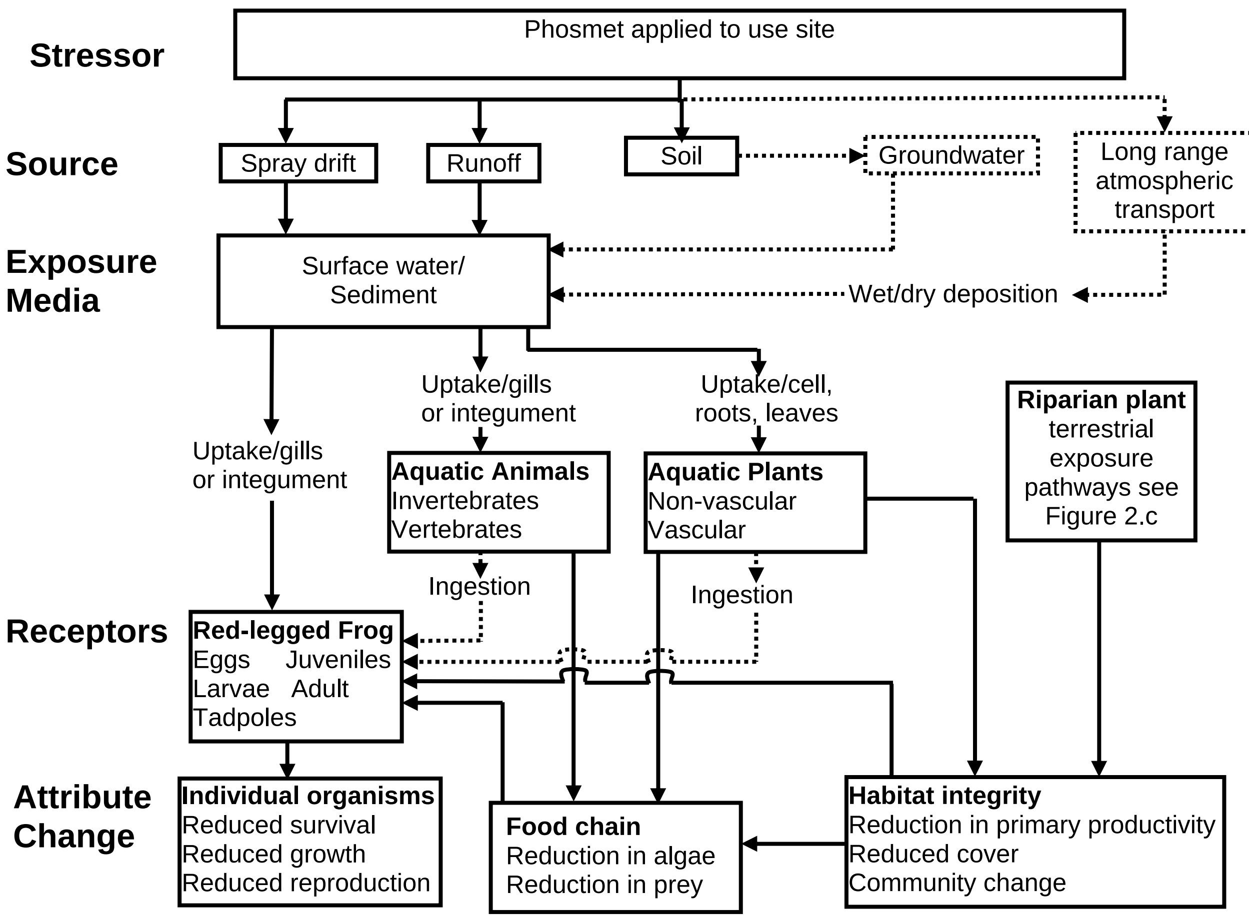


Figure 2.9 Conceptual Model for Potential Routes of Exposure to and Effects on Aquatic-Phase of the CRLF from the use of Phosmet in California.

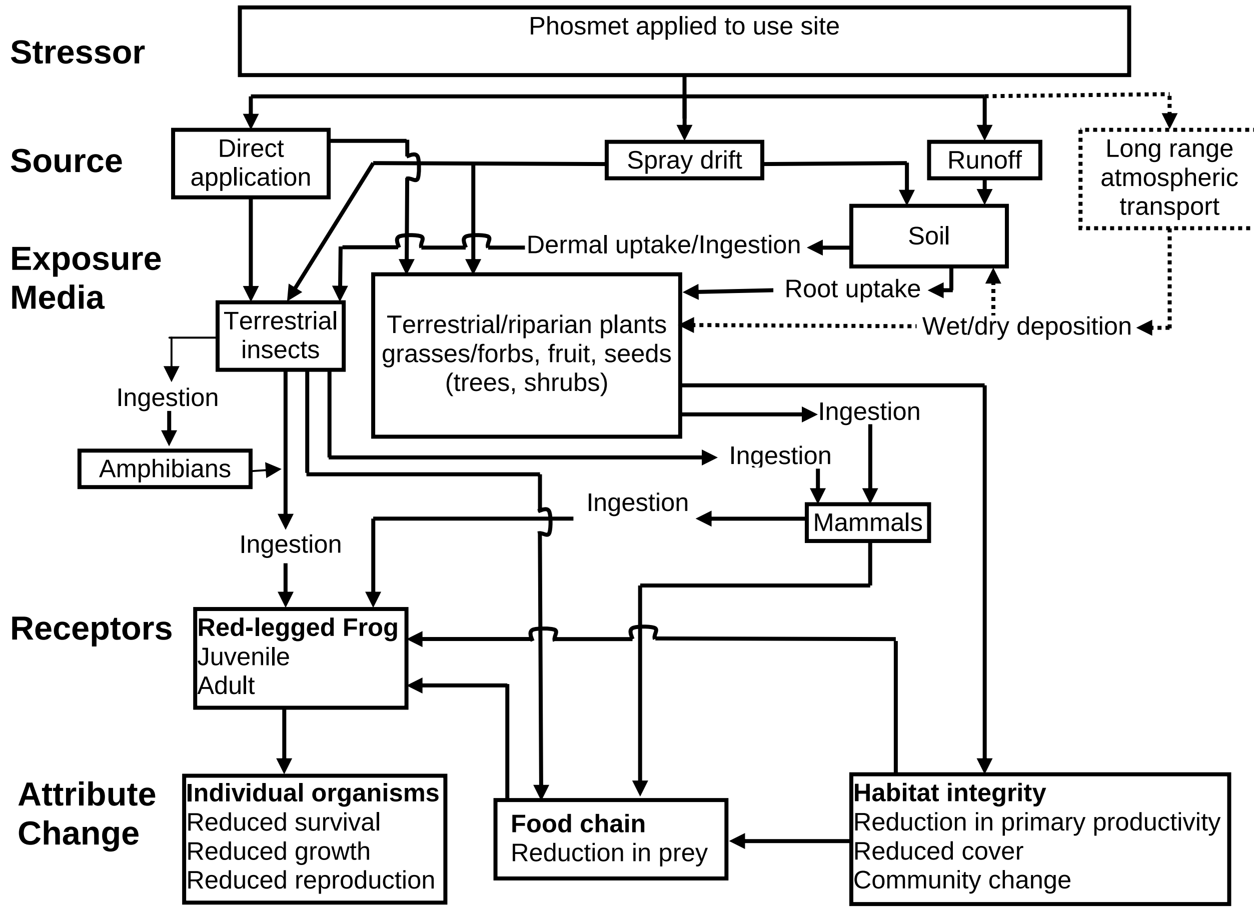


Figure 2.10 Conceptual Model for Potential Routes of Exposure to and Effects on Terrestrial-Phase of the CRLF from use of Phosmet in California.

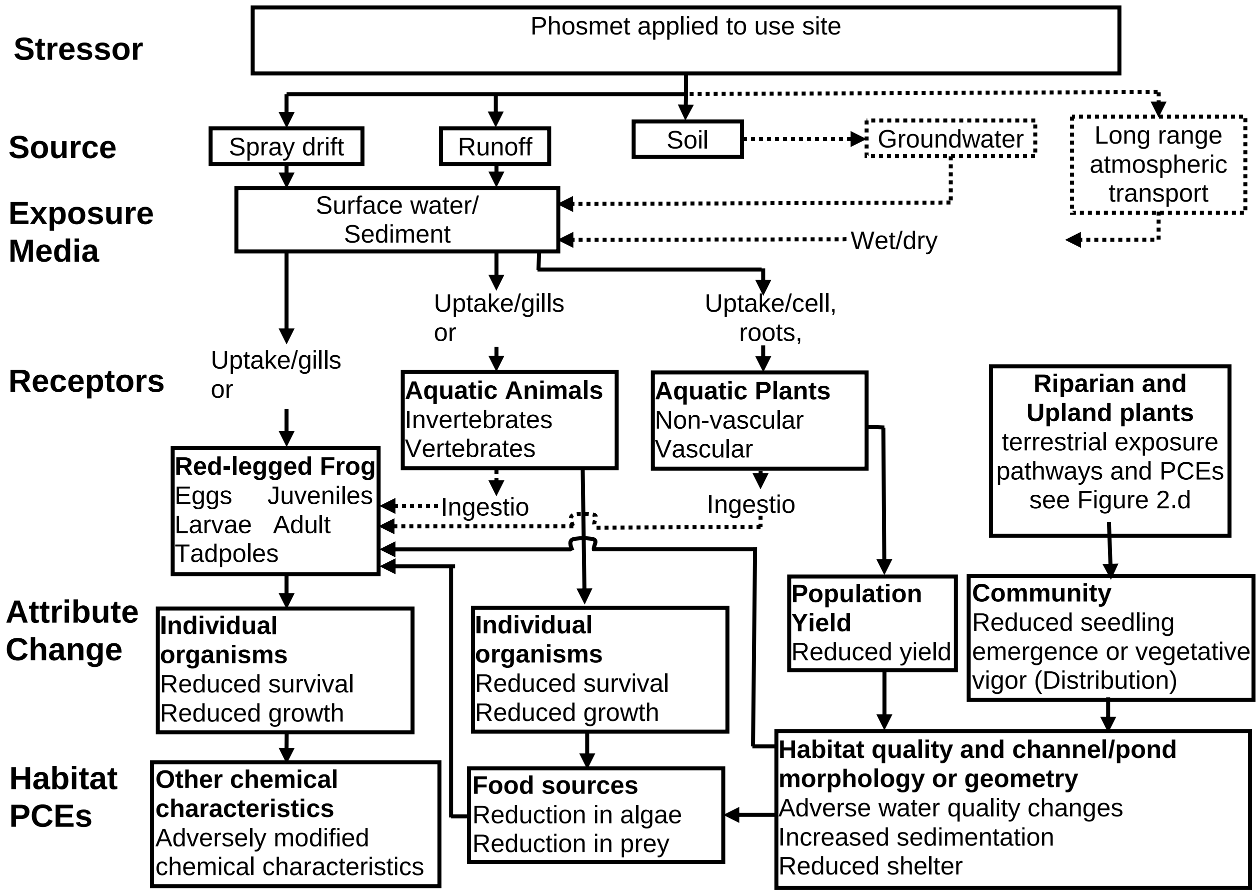


Figure 2.11 Conceptual Model for Potential Effects of Phosmet Use on Aquatic Component of CRLF Critical Habitat

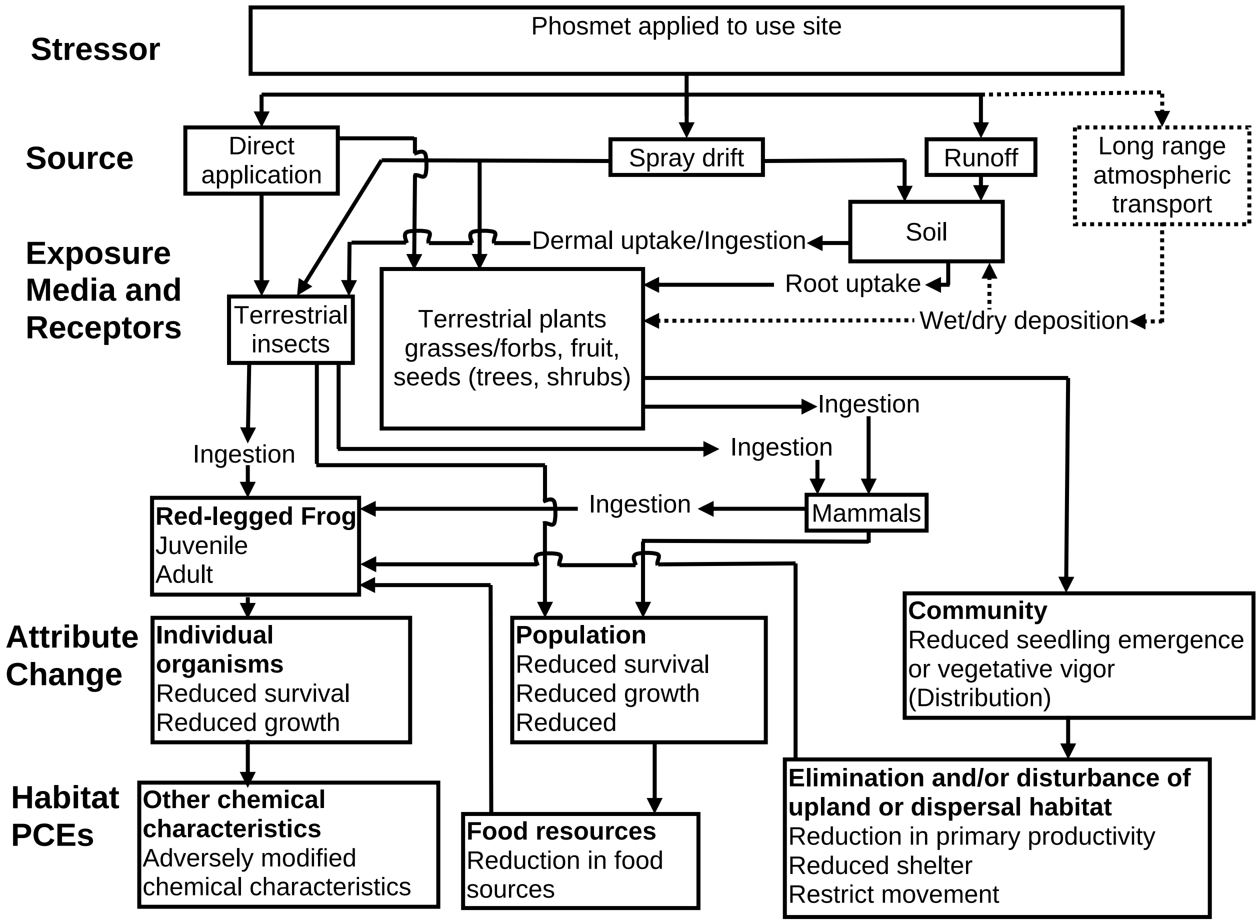


Figure 2.12 Conceptual Model for Potential Effects of Phosmet Use on Terrestrial Component of CRLF Critical Habitat

2.10 Analysis Plan

In order to address the risk hypotheses, the potential for direct and indirect effects to the CRLF, its prey, and its habitat is estimated. In the following sections, the use, environmental fate, and ecological effects of phosmet are characterized and integrated to assess the risks. This is accomplished using a risk quotient (ratio of exposure concentration to effects concentration) approach. Although risk is often defined as the likelihood and magnitude of adverse ecological effects, the risk quotient-based approach does not provide a quantitative estimate of likelihood and/or magnitude of an adverse effect. However, as outlined in the Overview Document (USEPA 2004), the likelihood of effects to individual organisms from particular uses of phosmet is estimated using the probit dose-response slope and either the level of concern (discussed below) or actual calculated risk quotient value.

2.10.1 Measures to Evaluate the Risk Hypothesis and Conceptual Model

2.10.1.1 Measures of Exposure

The environmental fate properties of phosmet along with available monitoring data indicate that runoff and spray drift are the principle potential transport mechanisms of phosmet to the aquatic and terrestrial habitats of the CRLF. Due to the water solubility and relatively low vapor pressure of phosmet, atmospheric transport is considered unlikely. In this assessment, transport of phosmet through runoff and spray drift is considered in deriving quantitative estimates of exposure to CRLF, its prey and its habitats.

Measures of exposure are based on aquatic and terrestrial models that predict estimated environmental concentrations (EECs) of phosmet using maximum labeled application rates and methods of application. The models used to predict aquatic EECs are the Pesticide Root Zone Model coupled with the EXposure Analysis Modeling System (PRZM/EXAMS). The model used to predict terrestrial EECs on food items is Terrestrial Residue Exposure (T-REX). The model used to derive EECs relevant to terrestrial and wetland plants is TerrPlant. These models are parameterized using relevant reviewed registrant-submitted environmental fate data.

PRZM (v3.12.2, 5/12/2005) and EXAMS (v2.98.4.6, 4/25/2005) are screening simulation models coupled with the input shell PE (v5.0, 11/15/2006) to generate daily exposures and 1-in-10 year EECs of phosmet that may occur in surface water bodies adjacent to application sites receiving phosmet through runoff and spray drift. PRZM simulates pesticide application, movement and transformation on an agricultural field and the resultant pesticide loadings to a receiving water body via runoff, erosion and spray drift. EXAMS simulates the fate of the pesticide and resulting concentrations in the water body. The standard scenario used for ecological pesticide assessments assumes application to a 10-hectare agricultural field that drains into an adjacent 1-hectare water body, 2-meters deep (20,000 m^3 volume) with no outlet. PRZM/EXAMS was used to estimate screening-level exposure of aquatic organisms to phosmet. The measure of exposure for aquatic species is the 1-in-10 year return peak or rolling mean concentration. The 1-in-10 year peak is used for estimating acute exposures of direct effects to the CRLF, as well as indirect effects to the CRLF through effects to potential prey items, including: algae, aquatic invertebrates, fish and frogs. The 1-in-10-year 60-day mean is used for assessing chronic exposure to the CRLF and fish and frogs serving as prey items; the 1-in-10-year 21-day mean is used for assessing chronic exposure for aquatic invertebrates, which are also potential prey items.

Exposure estimates for the terrestrial-phase CRLF and terrestrial invertebrates and mammals (serving as potential prey) assumed to be in the target area or in an area exposed to spray drift are derived using the T-REX model (v1.3.1, 12/07/2006). This model incorporates the Kenega nomograph, as modified by Fletcher *et al.* (1994), which is based on a large set of actual field residue data. The upper limit values from the nomograph represented the 95th percentile of residue values from actual field measurements (Hoerger and Kenega 1972). For modeling purposes, direct exposures of the CRLF to phosmet through contaminated food are estimated using the EECs for the small bird (20 g) which consumes small insects. Dietary-based and dose-based exposures of potential prey (small mammals) are assessed using the small mammal (15 g) which consumes short grass. The small bird (20g) consuming small insects and the small mammal (15g) consuming short grass are used because these categories represent the largest RQs of the size and dietary categories in T-REX that are appropriate surrogates for the CRLF and one of its prey items. Estimated exposures of terrestrial insects to phosmet are bounded by the dietary-based EECs for small insects and large insects.

Birds are currently used as surrogates for terrestrial-phase CRLF. However, amphibians are poikilotherms (body temperature varies with environmental temperature) while birds are homeotherms (temperature is regulated, constant, and largely independent of environmental temperatures). Therefore, amphibians tend to have much lower metabolic rates and lower caloric intake requirements than birds or mammals. As a consequence, birds are likely to consume more food than amphibians on a daily dietary intake basis, assuming similar caloric content of the food items. The use of avian food intake allometric equation as a surrogate to amphibians is likely to result in an over-estimation of exposure and risk for reptiles and terrestrial-phase amphibians. Therefore, T-REX (v1.3.1) has been refined to the Terrestrial Herpetofaunal Exposure and Residue Program Simulation (T-HERPS) model (v1.0, 5/15/2007), which allows for an estimation of food intake for poikilotherms using the same basic procedure as T-REX to estimate food intake.

EECs for terrestrial plants inhabiting dry and wetland areas are derived using TerrPlant (v1.2.2, 12/26/2006). This model uses estimates of pesticides in runoff and in spray drift to calculate EECs. EECs are based upon solubility, application rate and minimum incorporation depth.

2.10.1.2 Measures of Effect

Data identified in Section 2.8 are used as measures of effect for direct and indirect effects to the CRLF. Data were obtained from registrant-submitted studies or from literature studies identified by ECOTOX. The ECOTOXicology database (ECOTOX) was searched in order to provide more ecological effects data, for effects characterization, and in an attempt to bridge existing data gaps. ECOTOX is a source for locating chemical toxicity data for aquatic life, terrestrial plants, and wildlife. ECOTOX was created and is maintained by the USEPA, Office of Research and Development, and the National Health and Environmental Effects Research Laboratory's Mid-Continent Ecology Division.

The assessment of risk for direct effects to the terrestrial-phase CRLF makes the assumption that toxicity of phosmet to birds is similar to or less than the toxicity to the terrestrial-phase CRLF. The same assumption is made for fish and aquatic-phase CRLF. Algae, aquatic invertebrates, fish, and amphibians represent potential prey of the CRLF in the aquatic habitat. Terrestrial invertebrates, small mammals, and terrestrial-phase amphibians represent potential prey of the CRLF in the terrestrial habitat. Aquatic, semi-aquatic, and terrestrial plants represent habitat of CRLF.

The acute measures of effect used for animals in this screening-level assessment are the LD_{50}, LC_{50} and EC_{50}. LD stands for "Lethal Dose", and LD_{50} is the amount of a material, given all at once, that is estimated to cause the death of 50% of the test organisms. LC stands for “Lethal Concentration” and LC_{50} is the concentration of a chemical that is estimated to kill 50% of the test organisms. EC stands for “Effective Concentration” and the EC_{50} is the concentration of a chemical that is estimated to produce a specific effect in 50% of the test organisms. Endpoints for chronic measures of exposure for listed and non-listed animals are the NOAEL/NOAEC and NOEC. NOAEL stands for “No Observed-Adverse-Effect-Level” and refers to the highest tested dose of a substance that has been reported to have no harmful (adverse) effects on test organisms. The NOAEC (*i.e.*, “No-Observed-Adverse-Effect-Concentration”) is the highest test concentration at which none of the observed effects were statistically different from the control. The NOEC is the No-Observed-Effects-Concentration. For non-listed plants, only acute exposures are assessed (*i.e.*, EC_{25} for terrestrial plants and EC_{50} for aquatic plants).

2.10.1.3 Integration of Exposure and Effects

Risk characterization is the integration of exposure and ecological effects characterization to determine the potential ecological risk from agricultural and non-agricultural uses of phosmet, and the likelihood of direct and indirect effects to CRLF in aquatic and terrestrial habitats. The exposure and toxicity effects data are integrated in order to evaluate the risks of adverse ecological effects on non-target species. For the assessment of phosmet risks, the risk quotient (RQ) method is used to compare exposure and measured toxicity values. EECs are divided by acute and chronic toxicity values. The resulting RQs are then compared to the Agency’s levels of concern (LOCs) (USEPA 2004).

For this endangered species assessment, LOCs are used for comparing RQ values for acute and chronic exposures of phosmet to the CRLF and its habitat. If estimated exposures of phosmet resulting from a particular use are sufficient to exceed the listed species LOC, then the effects determination for that use is “may affect”. When considering indirect effects to the CRLF due to effects to animal prey (aquatic and terrestrial invertebrates, fish, frogs, and mice), the listed species LOCs are also used. If estimated exposures to CRLF prey of phosmet resulting from a particular use are sufficient to exceed the listed species LOC, then the effects determination for that use is a “may affect.” If the RQ being considered also exceeds the non-listed species acute risk LOC, then the effects determination is a LAA. If the acute RQ is between the listed species LOC and the non-listed acute risk species LOC, further lines of evidence (*e.g.* probability of individual effects, incident data) are considered in distinguishing between a determination of NLAA and a LAA. When considering indirect effects to the CRLF due to effects to algae as dietary items or plants as habitat, the non-listed species LOC for plants is used because the CRLF does not have an obligate relationship with any particular aquatic and/or terrestrial plant. If the RQ being considered for a particular use exceeds the non-listed species LOC for plants, the effects determination is “may affect”.

2.10.2 Data Gaps

The ecological effects data set for phosmet is largely complete, though many of the endpoints used in this assessment are from summary studies that typically lack some detailed information, such as dose response curve data and possible sublethal effects. Historically, however, the Agency has accepted studies (*e.g.* Hill and Camardese 1975) in lieu of registrant-submitted guideline studies, and considered the data sufficient to evaluate the potential for phosmet to impact nontarget animals.

There are no studies assessing the potential for phosmet to impact nontarget terrestrial plants. Given the breadth of crop species for which phosmet is labeled, the mode of action and the lack of plant incident data, the potential for injury to nontarget plants may be minimal. However, label restrictions state that sweet cherry (*Prunus* spp.) crops should not be treated with phosmet. Phosmet is known to cause premature leaf drop, particularly in some sweet cherry cultivars. This suggests some plant species may be sensitive to phosmet exposure. Given that other *Prunus* species and crops in the same family (Rosaceae) are labeled uses, sensitivity may be highly species-specific. The chemically-related organothiophosphate insecticide profenofos is also known to have phytotoxic effects. The lack of phytotoxicity data for phosmet is a source of considerable uncertainty in assessing the potential for direct and indirect adverse effects on non-target organisms.

As with terrestrial plants, there are no studies assessing the potential for phosmet to impact nontarget aquatic plants. For the reasons given above, this lack of data also represents an important uncertainty in this assessment. Conservative assumptions, as described later, will be used in the absence of these data.

3. Exposure Assessment

Phosmet is a broad-spectrum organophosphate insecticide/acaricide that is used for control of a variety of pests including the alfalfa weevil, boll weevil, codling moth, leafrollers, plum curculio, grape berrymoth, and the oriental fruit moth. Phosmet is applied to terrestrial food areas as a delayed dormant spray or foliar application with aerial and ground equipment. The maximum total annual application rate for current phosmet uses is assumed to be 130 pounds of active ingredient per acre (lbs a.i./A), although pending mitigation measures would reduce the maximum annual applications to 26 lbs ai/A for forestry uses and 11.9 lbs ai/A for crops (tree nuts).

3.1 Label Application Rates and Intervals

Phosmet labels may be categorized into two types: labels for manufacturing uses (including technical grade phosmet and its formulated products) and end-use products. While technical products, which contain phosmet of high purity, are not used directly in the environment, they are used to make formulated products, which can then be applied in specific areas to control insects. The formulated product labels legally limit the potential use of phosmet to only those sites that are specified on the labels.

Currently registered agricultural and non-agricultural uses of phosmet within California include those listed in **Table 2.3**.

3.2 Aquatic Exposure Assessment

3.2.1 Modeling Approach

Aquatic exposures are quantitatively estimated for all of the assessed uses using scenarios that represent high exposure sites for phosmet use. Each of these sites represents a 10-hectare field that drains into a 1-hectare pond that is 2 meters deep and has no outlet. Exposure estimates generated using the standard pond are intended to represent a wide variety of vulnerable water bodies that occur at the top of watersheds including prairie pot holes, playa lakes, wetlands, vernal pools, man-made and natural ponds, and intermittent and first-order streams. As a group, there are factors that make these water bodies more or less vulnerable than the standard surrogate pond. Static water bodies that have larger ratios of drainage area to water body volume would be expected to have higher peak EECs than the standard pond. These water bodies will be either shallower or have larger drainage areas (or both). Shallow water bodies tend to have limited additional storage capacity, and thus, tend to overflow and carry pesticide in the discharge whereas the standard pond has no discharge. As field size increases beyond 10 hectares, at some point, it becomes unlikely that the entire watershed is planted to a single crop, which is all treated with the pesticide. Headwater streams can also have peak concentrations higher than the standard pond, but they typically persist for only short periods of time and are then carried downstream.

3.2.2 Model Inputs

The model input parameters used in PRZM/EXAMS to simulate phosmet application-specific and chemical-specific parameters are listed in **Table 3.2** and **Table 3.3**. Crop-specific management practices for all of the assessed uses of phosmet were used for modeling, including application rates, number of applications per year, application intervals, and the first application date for each crop. The date of first application was developed based on several sources of information including data provided by BEAD, a summary of individual applications from the CDPR PUR data, and Crop Profiles maintained by the USDA. When a range of application dates was possible, the first application was chosen to correspond to the wetter portion of the year, winter/early spring. Standard and CRLF-specific PRZM crop scenarios, which consist of location-specific soils, weather, and cropping practices, were used in the simulations to represent labeled agricultural uses of phosmet. These scenarios were developed to represent high-end exposure sites in terms of vulnerability to runoff and erosion and subsequent off-site transport of pesticide.

Phosmet is registered on a wide variety of field, vegetable and orchard crops. Registered uses were grouped into categories according to similarity of crop growth and morphology, product use and cropping area; representative PRZM scenarios for each category were used for modeling. Particular attention was given to grouping crops according to the areas in which they are grown because rainfall is understood to be a driving variable in the PRZM model. Modeling inputs were selected according to EFED’s Input Parameter Guidance (USEPA 2002). Pesticide applications were simulated as aerial spray applications as prescribed by product labels. Foliar applications (PRZM chemical application method, CAM = 2) were simulated and default spray drift estimates were assumed. The disposition of the pesticide remaining on foliage after harvest

(PRZM variable IPSCND) was selected according to post-harvest cropping practices. Example output is included in **Appendix C**.

Table 3.1 Application-Specific PRZM/EXAMS Input Parameters Used in Aquatic Exposure Modeling for Phosmet.								
Category	**Uses**	**PRZM Scenario**	**App. rate (lbs ai/A)**	**# Apps/ year**	**Min. interval**	**IPSCND[1]**	**Date of 1st App**	**App. Date Comment**
Alfalfa	Alfalfa	CA alfalfa	1.0	9[2]	30[3]	2	March 1st	Cal PUR: majority of applications in March
Almonds	Almonds, walnuts, filberts, other tree nuts, pecans, pistachios	CA almond	5.95	2	5[3]	3	May 15th	Cal PUR: majority of applications occur between May - August
Citrus	Citrus	CA citrus	2.1	2	5[3]	3	April 1st	Cal PUR: limited data (1 app/year); spring application assumed
Cotton	Cotton	CA cotton	1.0	10	3	1	April 1st	Cal PUR: No application; spring applications assumed
Fruit tree	Apples, apricots, crab apples nectarines, peaches, pears, cherries, plums, prunes	CA fruit tree	5.0 (5.0, 5.0, 1.2)	26[4] (3)	5[3]	1	April 15th	Cal PUR: majority of applications occur between April - August
Grapes	Grapes	CA grapes	1.5 (1.0)	26[4] (3)	5[3]	1	May 1st	Cal PUR: majority of applications in May
Forestry	Christmas Tree, Conifer trees, deciduous trees	CA forestry	1.0 (1.1)	26[4] (3)	5[3]	1	June 1st	Cal PUR: limited data suggest summer applications
Potato	Potato, sweet potato	CA potato	0.9	5	10	1	April 1st	Cal PUR: No application; spring applications assumed
Vegetables	Peas	CA row crop	1.0	3	5[3]	1	April 1st	Cal PUR: No application; spring applications assumed
Blueberries	Blueberries	CA wine grapes	1.0	5	5[3]	1	April 1st	Cal PUR: No application; spring applications assumed

[1] Flag indicating the disposition of pesticide remaining on foliage after harvest; 1 - pesticide remaining on foliage is converted to surface application, 2 - remaining pesticide on foliage is completely removed, 3- remaining pesticide on foliage is retained as surface residue and continues to undergo decay.
[2] Label specifies 1 application per cutting, according to information provided by BEAD (Kaul, 2007. Maximum Number of Crop Cycles Per Year in California for Methomyl Use Sites), there are up to 9 cuttings of alfalfa per year in California.
[3] Minimum interval not specified on label.
[4] Maximum number of application per year not specified on label.

Table 3.2 Chemical-Specific PRZM/EXAMS Input Parameters Used in Aquatic Exposure Modeling for Phosmet.			
Input Parameter	**Value**	**Source**	**Comment**
Molecular mass (g/mol)	317.3	Product chemistry	
Vapor pressure (Torr)	4.5×10^{-7}	Product chemistry	
Henry's law constant ($atm\text{-}m^3/mol$)	7.5×10^{-9}	Calculated	HLC = (VP/760) / (SOL/MWT)
Water solubility (mg/L)	250	Product chemistry	multiplied by 10[1]
Adsorption partition coefficient (K_d, ml/g_{oc})	10.7	MRID 40599002	Mean of four values[1]
Aerobic soil metabolism $t_{1/2}$ (d)	81	MRID 00112304	3x aerobic soil $t_{1/2}$ [1]
Aerobic aquatic metabolism $t_{1/2}$ (d)	0	--	No data; assumed stable. Aquatic degradation driven by hydrolysis
Anaerobic aquatic metabolism $t_{1/2}$ (d)	0	--	No data; assumed stable. Aquatic degradation driven by hydrolysis
Hydrolysis $t_{1/2}$ (d)	0.39	MRID 40394301	pH 7
Photolysis $t_{1/2}$ (d)	0	MRID 42607901	Stable
Foliar extraction	0.5		Default
Decay rate on foliage (d)	0		Assume stable (default)
[1]. EFED input parameter guidance is located at: http://www.epa.gov/oppefed1/models/water/input_guidance2_28_02.htm.			

Aquatic EECs for the various use categories are listed in **Table 3.4**. Peak aquatic EECs range from 3.5 – 78 µg/L for potatoes and fruit trees, respectively. Considering only the proposed mitigated rates, the maximum peak concentration is 23 µg/L for the tree nuts (almonds). The unmitigated fruit tree category resulted in the highest EECs with 1-in-10 year peak, 21-day and 60-day concentrations of 78, 5.9 and 3.7 µg/L, respectively. The variability in EECs is driven by yearly application rate, application timing relative to rainfall events and variability in the vulnerability of the PRZM scenario (rainfall and soils).

Table 3.3 1-in-10 Year Aquatic Estimated Environmental Concentrations (in µg/L) from PRZM/EXAMS Modeling for Maximum Use Patterns of Phosmet.				
Use category	**Yearly app. rate (lbs ai/A/yr)**	**Peak (µg/L)**	**21-day (µg/L)**	**60-day (µg/L)**
Alfalfa	9.0	9.2	0.47	0.23
Almonds[1]	12	23	1.4	0.57
Citrus	4.2	5.8	0.39	0.15
Cotton	10	13	1.2	0.54
Fruit tree[2]	130	78	5.9	3.7
Fruit tree (mitigated label)	*11*	*17*	*1.8*	*0.76*
Grapes	39	27	1.6	1.1
Grapes (mitigated label)	*4.6*	*6.9*	*0.81*	*0.30*
Forestry[4]	26	24	2.9	1.5
Forestry (mitigated label)	*3.3*	*6.4*	*0.55*	*0.38*
Potato[5]	4.5	3.5	0.31	0.19
Truck vegetables[6]	3.0	4.9	0.41	0.15
Blueberries	5.0	4.3	0.59	0.21

[1] almonds, walnuts, filberts, other tree nuts, pecans, pistachios
[2] apples, Apricots, crab apples nectarines, peaches, pears, cherries, plums, prunes
[3] flowering trees, ornamental plants and non-bearing fruit and nut tree
[4] Christmas tree, conifer trees, deciduous trees
[5] potato, sweet potato
[6] peas

3.2.4 Existing Monitoring Data

Phosmet has a limited set of surface water monitoring data relevant to the CRLF assessment. No surface water monitoring studies which specifically targeted phosmet use (application period and/or sites) were available for analysis as part of this assessment. Generally, targeted monitoring data are collected with a sampling program designed to capture, both spatially and temporally, the maximum use of a particular pesticide. Typically, sampling frequencies employed in monitoring studies are insufficient to document peak exposure values. The lack of targeted data coupled with the fact that these data are not temporally or spatially correlated with pesticide application times and/or areas limit the utility of these data in estimating exposure concentrations for risk assessment purposes. Therefore model-generated values are used for estimating acute and chronic exposure values, and the non-targeted monitoring data are typically used for qualitative characterizations. Included in this assessment are phosmet data from the USGS NAWQA program (http://water.usgs.gov/nawqa) and data from the California Department of Pesticide Regulation (CDPR).

3.2.4.1 USGS NAWQA Surface Water Data

Surface water monitoring data from the United States Geological Survey (USGS) NAWQA program were obtained on February 20, 2008. A total of 2233 water samples across various sites throughout the US were analyzed for phosmet. This included 210 samples taken in CA at 15 sites located in five counties (Merced, Riverside, Sacramento, San Joaquin, and Stanislaus) between October 2001 and September 2006. There were no positive detections of phosmet reported above the level of detection which ranged from 0.0018 to 0.021 µg/L.

A total of 2,084 water samples across various sites throughout the US were analyzed for phosmet oxon. Of these samples, six samples had positive detections with estimated concentrations ranging from 0.0069 to 0.045 µg/L. Reported levels of detection ranged from 0.016 to 0.26 µg/L. The six detections were reported from three sites in Merced County, CA all sampled in February 2004. These detections of phosmet oxon were not concurrent with detections of phosmet parent (as noted above, phosmet has not been reported above detection limits in NAWQA). One of the three sites is reported as agricultural land use and two are reported as "other" land use. There were 211 samples taken in CA at 15 sites located in five counties (Merced, Riverside, Sacramento, San Joaquin, and Stanislaus) between October 2001 and September 2006.

3.2.4.2 California Department of Pesticide Regulation (CDPR) Data

Surface water monitoring data were obtained from the California Department of Pesticide regulation (CDPR) on February 20, 2008, and all data with analysis for phosmet and/or phosmet oxon were extracted. A total of 1,683 water samples were analyzed for phosmet and 635 samples analyzed for phosmet oxon. There were two detections of phosmet (0.3 and 0.63 µg/L) and no detections of phosmet oxon. Both detections of phosmet were reported from two sites on the Alamo River in Imperial County on March 15, 1993.

3.2 Terrestrial Animal Exposure Assessment

T-REX (Version 1.3.1) is used to calculate dietary and dose-based EECs of phosmet for the CRLF and its potential prey (*e.g.* small mammals and terrestrial insects) inhabiting terrestrial areas. EECs used to represent the CRLF are also used to represent exposure values for frogs serving as potential prey of CRLF adults. T-REX simulates a 1-year time period. For this assessment, spray applications of phosmet are considered, as discussed below.

Terrestrial EECs of phosmet were derived for the uses summarized in **Table 3.7**. Foliar dissipation data are available for phosmet (Willis and McDowell 1987) and based on those data an upper-bound dissipation half-life of four days is used as input to T-REX. Use-specific input values, including number of applications, application rate and application interval are provided in **Table 3.4**. An example output from T-REX is available in **Appendix D**.

Table 3.4 Input Parameters for Foliar Applications Used to Derive Terrestrial EECs for Phosmet with T-REX			
Use (Application method)	**Application rate (lbs ai/A)**	**Number of Applications (values in parentheses represent assumed number of applications)**	**Reapplication Interval (days)**
Alfalfa	1.0 (per cutting)	9 (assuming 9 cuttings per year)	NS (30) *
Almonds, walnuts, filberts, other tree nuts, pecans, pistachios	5.95	2	NS (5)
Citrus	2.1	2	NS (5)
Cotton	1.0	10	3
Apples, Apricots, crab apples nectarines, peaches, pears, cherries, plums, prunes	5.0	NS (26)	NS (5)
Grapes	1.5	NS (26)	NS (5)
Christmas Tree, Conifer trees, deciduous trees	1.0	NS (26)	NS (5)
Potato, sweet potato	0.9	5	10
Peas	1.0	3	NS (5)
Blueberries	1.0	5	NS (5)

*NS (value)—not specified by label (assumed value for modeling).

T-REX is also used to calculate EECs for terrestrial insects exposed to phosmet. Dietary-based EECs calculated by T-REX for small and large insects (units of ai/g) are used to bound an estimate of exposure to bees. Available acute contact toxicity data for bees exposed to phosmet (in units of µg ai/bee), are converted to µg ai/g (of bee) by multiplying by 1 bee/0.128 g. The EECs are later compared to the adjusted acute contact toxicity data for bees in order to derive RQs.

For modeling purposes, exposures of the CRLF to phosmet through contaminated food are estimated using the EECs for the small bird (20 g) which consumes small insects. Dietary-based and dose-based exposures of potential prey are assessed using the small mammal (15 g) which consumes short grass. Upper-bound Kenega nomogram values reported by T-REX for these two organism types are used for derivation of EECs for the CRLF and its potential prey (**Table 3.5**). Dietary-based EECs for small and large insects reported by T-REX are presented in **Table 3.6**. .

Table 3.5 Upper-bound Kenega Nomogram EECs for Dietary- and Dose-based Exposures of the CRLF and its Prey to Phosmet				
Use	**EECs for CRLF**		**EECs for Prey (small mammals)**	
	Dietary-based EEC (ppm)	**Dose-based EEC (mg/kg-bw)**	**Dietary-based EEC (ppm)**	**Dose-based EEC (mg/kg-bw)**
Alfalfa	136	155	241	230
Almonds, walnuts, filberts, other tree nuts, pecans, pistachios	1141	1299	2028	1934
Citrus	403	459	716	683
Cotton	331	377	589	561
Apples, Apricots, crab apples nectarines, peaches, pears, cherries, plums, prunes	1165	1326	2071	1974
Grapes	349	398	621	592
Christmas Tree, Conifer trees, deciduous trees	233	265	414	395
Potato, sweet potato	206	235	368	350
Peas	216	246	383	365
Blueberries	230	262	409	390

Table 3.6 EECs (ppm) for Indirect Effects to the Terrestrial-Phase CRLF via Effects to Terrestrial Invertebrate Prey Items		
Use	**Small Insect**	**Large Insect**
Alfalfa	136	15
Almonds, walnuts, filberts, other tree nuts, pecans, pistachios	1141	127
Citrus	403	45
Cotton	331	37
Apples, Apricots, crab apples nectarines, peaches, pears, cherries, plums, prunes	1165	129
Grapes	349	39
Christmas Tree, Conifer trees, deciduous trees	233	26
Potato, sweet potato	146	16
Peas	216	24
Blueberries	230	26

3.3 Terrestrial Plant Exposure Assessment

TerrPlant (v1.1.2) is used to calculate EECs for non-target plant species inhabiting dry and semi-aquatic areas. Parameter values for application rate, drift assumption and incorporation depth are based upon the use and related application method. A runoff value of 2% is utilized based on TerrPlant's classification of phosmet's solubility (25 mg/L). For aerial and ground application methods, drift is assumed to be 5% and 1%, respectively. EECs relevant to terrestrial plants consider pesticide concentrations in drift and in runoff. TerrPlant only considers a single application. These EECs are listed by use in **Table 3.7**.

Table 3.7 TerrPlant Inputs and Resulting EECs for Plants Inhabiting Dry and Semi-aquatic Areas Exposed to Phosmet via Runoff and Drift. Aerial applications are presented here; ground applications have lower drift values.

Use(s)	Max. Single App. Rate (lbs a.i./A)	Spray drift EEC (lbs a.i./A)	Dry area EEC (lbs a.i./A)	Semi-aquatic area EEC (lbs a.i./A)
Alfalfa	1.0 (per cutting)	0.05	0.07	0.25
Almonds, walnuts, filberts, other tree nuts, pecans, pistachios	5.95	0.30	0.42	1.49
Citrus[2]	2.1	0.10	0.15	0.52
Cotton[2]	1.0	0.05	0.07	0.25
Apples, Apricots, crab apples nectarines, peaches, pears, cherries, plums, prunes	5.0	0.25	0.35	1.25
Grapes[3]	1.5	0.08	0.10	0.38
Christmas Tree, Conifer trees, deciduous trees	1.0	0.05	0.07	0.25
Potato, sweet potato	0.9	0.04	0.06	0.22
Peas	1.0	0.05	0.07	0.25
Blueberries	1.0	0.05	0.07	0.25

4. Effects Assessment

This assessment evaluates the potential for phosmet to directly or indirectly affect the CRLF or modify its designated critical habitat. As previously discussed in Section 2.7, assessment endpoints for the CRLF include direct toxic effects on the survival, reproduction, and growth of CRLF, as well as indirect effects, such as reduction of the prey base or modification of its habitat. In addition, potential modification of critical habitat is assessed by evaluating effects to the PCEs, which are components of the critical habitat areas that provide essential life cycle needs of the CRLF. Direct effects to the aquatic-phase of the CRLF are based on toxicity information for freshwater fish, while terrestrial-phase effects are based on avian toxicity data, given that birds are generally used as a surrogate for terrestrial-phase amphibians. Because the frog's prey items and habitat requirements are dependent on the availability of freshwater fish and invertebrates, small mammals, terrestrial invertebrates, and aquatic and terrestrial plants, toxicity information for these taxa are also discussed. Acute (short-term) and chronic (long-term) toxicity information is characterized based on registrant-submitted studies and a comprehensive review of the open literature on phosmet.

As described in the Agency's Overview Document (USEPA 2004), the most sensitive endpoint for each taxon is used for risk estimation. For this assessment, evaluated taxa include aquatic-phase amphibians, freshwater fish, freshwater invertebrates, aquatic plants, birds (surrogate for terrestrial-phase amphibians), mammals, terrestrial invertebrates, and terrestrial plants.

Toxicity endpoints are established based on data generated from guideline studies submitted by the registrant, and from open literature studies that meet the criteria for inclusion into the ECOTOX database maintained by EPA/Office of Research and Development (ORD) (U.S. EPA, 2004). Open literature data presented in this assessment were obtained from ECOTOX information obtained in December 2007. In order to be included in the ECOTOX database, papers must meet the following minimum criteria:

(1) the toxic effects are related to single chemical exposure;
(2) the toxic effects are on an aquatic or terrestrial plant or animal species;
(3) there is a biological effect on live, whole organisms;
(4) a concurrent environmental chemical concentration/dose or application rate is reported; and
(5) there is an explicit duration of exposure.

Data that pass the ECOTOX screen are evaluated along with the registrant-submitted data, and may be incorporated qualitatively or quantitatively into this endangered species assessment. In general, effects data in the open literature that are more conservative than the registrant-submitted data are considered. The degree to which open literature data are quantitatively or qualitatively characterized is dependent on whether the information is relevant to the assessment endpoints (*i.e.*, maintenance of CRLF survival, reproduction, and growth) identified in Section 2.8. For example, endpoints such as behavior modifications are likely to be qualitatively evaluated, because quantitative relationships between modifications and reduction in species survival, reproduction, and/or growth are not available.

Citations of all open literature not considered as part of this assessment because they were either rejected by the ECOTOX screen or accepted by ECOTOX but not used (*e.g.*, the endpoint is less sensitive and/or not appropriate for use in this assessment) are included in **Appendix E.** **Appendix E** also includes a rationale for rejection of those studies that did not pass the ECOTOX screen and those that were not evaluated as part of this endangered species risk assessment. **Appendix F** contains the endpoints summarized from the papers acceptable for use in the assessment.

In addition to registrant-submitted and open literature toxicity information, other sources of information, including use of the acute probit dose-response relationship to establish the probability of an individual effect and reviews of the Ecological Incident Information

System (EIIS), are conducted to further refine the characterization of potential ecological effects associated with exposure to phosmet. A summary of the available aquatic and terrestrial ecotoxicity information, use of the probit dose-response relationship, and the incident information for phosmet are provided in Sections 4.1 through 4.4, respectively.

No data are available on the toxicity of the major degradates of phosmet or phosmet oxon.

No toxicity data were available on phosmet mixtures with other pesticides; no multi-ai products are registered for phosmet.

4.1 Toxicity of Phosmet to Aquatic Organisms

Table 4.1 summarizes the most sensitive aquatic toxicity endpoints for the CRLF, based on an evaluation of both the submitted studies and the open literature, as previously discussed. A brief summary of submitted and open literature data considered relevant to this ecological risk assessment for the CRLF is presented below.

Table 4.1 Freshwater Aquatic Toxicity Profile for Phosmet

Assessment Endpoint	Species (Common Name)	Endpoint	Mean Concentration (mg/L)	Reference (MRID)
Acute Direct Toxicity to Aquatic-Phase CRLF	*Lepomis macrochirus* (Bluegill Sunfish)	96-hr LC_{50}	0.07	000631-94
Chronic Direct Toxicity to Aquatic-Phase CRLF	*Oncorhyncus mykiss* (Rainbow Trout)	NOAEC	0.0032	409387-01
Indirect Toxicity to Aquatic-Phase CRLF via Acute Toxicity to Freshwater Invertebrates (*i.e.* prey items)	*Gammarus fasciatus* (Scud)	48-hr EC_{50}	0.002	000631-93
Indirect Toxicity to Aquatic-Phase CRLF via Chronic Toxicity to Freshwater Invertebrates (*i.e.* prey items)	*Daphnia magna* (Waterflea)	NOAEC/LOAEC	0.0008 / 0.0011	406528-01
Indirect Toxicity to Aquatic-Phase CRLF via Acute Toxicity to Non-vascular Aquatic Plants	No Data	5-day EC_{50} NOAEC	0.034 0.004	estimate from chlorpyrifos
Indirect Toxicity to Aquatic-Phase CRLF via Acute Toxicity to	No Data	14-day EC_{50} NOAEC	>1.8 1.8	estimate from naled

Vascular Aquatic Plants				

Toxicity to aquatic fish and invertebrates is categorized using the system shown in **Table 4.2** (U.S. EPA, 2004). Toxicity categories for aquatic plants have not been defined.

Table 4.2 Categories of Acute Toxicity for Aquatic Organisms

LC_{50} (ppm)	Toxicity Category
< 0.1	Very highly toxic
> 0.1 - 1	Highly toxic
> 1 - 10	Moderately toxic
> 10 - 100	Slightly toxic
> 100	Practically nontoxic

4.1.1 Toxicity to Freshwater Fish

Given that no guideline phosmet toxicity data are available for aquatic-phase amphibians, freshwater fish data were used as a surrogate to estimate direct acute and chronic risks to the CRLF. Freshwater fish toxicity data were also used to assess potential indirect effects of phosmet to the CRLF. Effects to freshwater fish resulting from exposure to phosmet could indirectly affect the CRLF via reduction in available food. As discussed in Section 2.5.3, over 50% of the prey mass of the CRLF may consist of vertebrates such as mice, frogs, and fish (Hayes and Tennant, 1985).

A summary of acute and chronic freshwater fish data, including data from the open literature, is provided below in Sections 4.1.1.1 through 4.1.1.3.

4.1.1.1 Freshwater Fish: Acute Exposure (Mortality) Studies

There are several reviewed studies that have evaluated the acute toxicity of phosmet technical to freshwater fish. Based on reported study results, 96-hr LC_{50}s ranged from 0.07 mg ai/L for bluegill sunfish (*Lepomis macrochirus*) to 11.0 mg ai/L for channel catfish (*Ictalurus punctatus*). Since the LC_{50} values ranged from 0.07 - 11.0 ppm, phosmet technical is classified as slightly toxic to very highly toxic to freshwater fish on an acute exposure basis. Of the available studies, only one (MRID 00109135) provides sufficient data to calculate a dose-response slope. The slope derived for rainbow trout is 3.3, and will be used in place of the default slope (4.5) in the estimating the likelihood of individual mortality for the aquatic-phase CRLF and its aquatic vertebrate prey items. The LC_{50} from that rainbow trout (*Oncorhynchus mykiss*) study is 0.23 mg ai/L, but the more sensitive endpoint, *i.e.*, bluegill sunfish 96-hr LC_{50} of 0.07 mg ai/L, is used for RQ calculation.

Several studies with formulated phosmet (50% ai) are also available. As with phosmet technical, there is a relatively wide range of sensitivity, from 0.29 mg/L for rainbow trout to 9.0 mg/L for fathead minnow (*Pimephales promelas*). In general though, the formulated end-use product is less toxic than the technical grade active ingredient.

4.1.1.2 Freshwater Fish: Chronic Exposure (Growth/Reproduction) Studies

A fish early life stage (ELS) study is available to evaluate the chronic toxicity of phosmet to rainbow trout. The NOAEC is 0.003 mg/L, based on a 4% reduction in 35-day post-hatch growth at the LOAEC (0.006 mg/L). The reduction in growth (length) persisted through 60-days post-hatch, the last measured time-step. Growth was reduced by 15% 35-day post-hatch at the highest concentration tested (0.051 mg/L). Fry survival was reduced 7% at 0.012 mg/L 35-day post-hatch.

4.1.1.3 Freshwater Fish: Sublethal Effects and Additional Open Literature Information

One paper was accepted by ECOTOX evaluating the toxicity of phosmet to fish (Julin and Sanders 1977) reporting a 96-hr LC_{50} of 0.5 mg ai/L for rainbow trout, which is comparable to the registrant-submitted study. Two additional rainbow trout endpoints, 24-hr LC_{50} values, are both about 0.75 mg ai/L. The same paper reports a 24-hr LC_{50} for channel catfish of 13 mg ai/L. No additional data are available in ECOTOX on either the acute or chronic toxicity of phosmet to freshwater fish.

4.1.1.4 Aquatic-phase Amphibian: Acute and Chronic Studies

No registrant-submitted nor ECOTOX data are available on either the acute or chronic toxicity of phosmet to aquatic-phase amphibians.

4.1.2 Toxicity to Freshwater Invertebrates

Freshwater aquatic invertebrate toxicity data are used to assess potential indirect effects of phosmet to the CRLF. Effects to freshwater invertebrates resulting from exposure to phosmet could indirectly affect the CRLF via reduction in available food items. As discussed in Section 2.5.3, a main food source for juvenile aquatic- and terrestrial-phase CRLFs is thought to be aquatic invertebrates found along the shoreline and on the water surface, including aquatic sowbugs, larval alderflies and water striders.

A summary of acute and chronic freshwater invertebrate data, including data published in the open literature, is provided below in Sections 4.1.2.1 through 4.1.2.3.

4.1.2.1 Freshwater Invertebrates: Acute Exposure Studies

There are two studies on the acute toxicity of phosmet to freshwater aquatic invertebrates. The EC_{50} for the scud (*Gammarus fasciatus*) is 0.002 mg ai/L and the EC_{50} for waterfleas (*Daphnia magna*) is 0.006 mg ai/L, resulting in phosmet being classified as very highly toxic to freshwater invertebrates on an acute exposure basis. No additional acute data are available on sublethal effects to aquatic invertebrates.

Two acute toxicity studies with formulated phosmet (51% ai) using waterfleas result in EC_{50}s of 0.009 to 0.024 mg/L; as such, the toxicity of the formulated product is roughly equivalent to that of the technical grade active ingredient.

4.1.2.2 Freshwater Invertebrates: Chronic Exposure Studies

Data from a flow-through life-cycle test with *D. magna* were reviewed. Phosmet affected the growth of daphnid adults (6%) and mean number of offspring (27%) at exposure concentrations as low as 0.001 mg ai/L. The NOAEC for the daphnid life-cycle test is 0.0008 mg ai/L.

4.1.2.3 Freshwater Invertebrates: Open Literature Data

Acceptable data evaluating the toxicity of phosmet to the aquatic sowbug (*Asellus brevicaudus*) and the scud (*Gammerus pseudolimnaeus*) are available in Julin and Sanders (1977). The reported 48-hr LC_{50} for the sowbug is 0.1 mg ai/L and for the scud is 0.0024 mg ai/L. While mosquitoes tend to be target species, Simonet *et al*. (1978) reports an EC_{50} for negative phototactic response of the yellow fever mosquito (*Aedes aegypti*) larvae of 0.0049 mg ai/L.

4.1.3 Toxicity to Aquatic Plants

Aquatic plant toxicity studies are unavailable to evaluate whether phosmet could affect primary production and the availability of aquatic plants as food for CRLF tadpoles. Primary productivity is essential for supporting the growth and abundance of the CRLF.

Laboratory studies are not available to determine whether phosmet may cause direct effects to aquatic vascular plants, nor are there open literature data. There are data for the effects of two organophosphate insecticides on duckweed (*Lemna gibba*) in the Agency's Pesticide Ecotoxicity Database (PED). The database reports a 14-day EC50 of >1.8 mg ai/L for naled, and a 9-day EC50 of 103 mg ai/L for sulprofos, which, like phosmet, is an organothiophosphate chemical. Given the scarcity of data for organophosphate chemicals (non-herbicides), the non-definitive EC_{50} value for naled will be used for RQ calculation. Agency guideline studies typically stipulate 96-hr studies and the currently available data on aquatic vascular plants are for considerably longer exposure periods. Therefore, there is considerable uncertainty surrounding the use of the naled value; however, it represents a best available estimate for organophosphate pesticides.

There are no laboratory studies evaluating the effects of phosmet on nonvascular aquatic plants. However, a QSAR (Quantitative Structural-Activity Relationship) model estimated EC_{50} of 2.2 mg ai/L indicates the potential sensitivity of green algae (ECOSAR 2008). There are data in the PED for 15 organophosphate insecticides/nematacides to a variety of nonvascular plants (diatoms, green algae and cyanobacteria). Not all chemicals have data for the same species, nor are the studies of the same duration, but generally values are greater than 1.0 mg ai/L. EC_{50} values for two chemicals (naled and chlorpyrifos) are below that threshold. Data for naled range from 0.012 mg ai/L

(*Navicula pellicosa*) to 0.64 mg ai/L (*Anabaena flos-aquae*), with a mean EC_{50} value of 0.172 mg ai/L. The values for chlorpyrifos are for *Isochrysis galbana*, a brown algae (EC_{50} = 0.140 mg ai/L), *Selenastrum capricornutum*, a green algae (EC_{50} = 0.150 mg ai/L) and *Thalassiosira* spp., a diatom (EC_{50} = 0.3 mg ai/L). Given that the mean sensitivity to naled is similar to the sensitivities to chlorpyrifos, the lowest chlorpyrifos EC_{50} value (0.140 mg ai/L) is used as a conservative estimate for phosmet in this assessment. Since naled appears to be the most sensitive aquatic plant data for the organophosphate insecticides, this evaluation will also rely on the measured NOAEC value and the extrapolated EC_{05} value for naled in *N. pelliculosa* and *Pseudokirchneriella subcapitatum*, both of which are 0.004 mg a.i./L.

4.1.4 Freshwater Field/Mesocosm Studies

No freshwater field and/or mesocosm studies are available for phosmet.

4.2 Toxicity of Phosmet to Terrestrial Organisms

Table 4.3 summarizes the most sensitive terrestrial toxicity endpoints for the CRLF, based on an evaluation of both the submitted studies and the open literature. A brief summary of submitted and open literature data considered relevant to this ecological risk assessment for the CRLF is presented below.

Table 4.3 Terrestrial Toxicity Profile for Phosmet

Endpoint	Species (Common Name)	Endpoint	Mean Concentration	Reference (MRID)
Acute Direct Toxicity to Terrestrial-Phase CRLF (LD_{50})	*Anas platyrhynchos* (Mallard duck)	24-hr LD_{50}	>2000 mg/kg bw[a]	000844-60
Acute Direct Toxicity to Terrestrial-Phase CRLF (LC_{50})	*Colinus virginianus* (Bobwhite Quail)	8-day LC_{50}	501 mg/kg diet	000229-23
Chronic Direct Toxicity to Terrestrial-Phase CRLF	Mallard duck Bobwhite Quail	NOAEC	60 ppm	001257-86 001059-99
Indirect Toxicity to Terrestrial-Phase CRLF (via acute toxicity to mammalian prey items)	*Rattus norvegicus* (Laboratory rat)	96-hr LD_{50}	113 mg/kg bw	00461-89
Indirect Toxicity to Terrestrial-Phase CRLF (via chronic	Laboratory rat	NOAEC / LOAEC	1.5 mg/kg/day / 6.1mg/kg/day	415200-01

Table 4.3 Terrestrial Toxicity Profile for Phosmet				
Endpoint	**Species (Common Name)**	**Endpoint**	**Mean Concentration**	**Reference (MRID)**
toxicity to mammalian prey items)				
Indirect Toxicity to Terrestrial-Phase CRLF (via acute toxicity to terrestrial invertebrate prey items)	*Apis mellifera* (Honey bee)	48-hr LD_{50}	1.1 µg/bee	000662-20
Indirect Toxicity to Terrestrial- and Aquatic-Phase CRLF (via toxicity to terrestrial plants)	Seedling Emergence Monocots	EC_{25}	0.13 lb ai/A	Estimate from propenofos
	Seedling Emergence Dicots	EC_{25}	0.13 lb ai/A	Estimate from propenofos
	Vegetative Vigor Monocots	EC_{25}	0.13 lb ai/A	Estimate from propenofos
	Vegetative Vigor Dicots	EC_{25}	0.13 lb ai/A	Estimate from propenofos

Acute toxicity to terrestrial animals is categorized using the classification system shown in **Table 4.4** (U.S. EPA, 2004). Toxicity categories for terrestrial plants have not been defined.

Table 4.4 Categories of Acute Toxicity for Avian and Mammalian Studies		
Toxicity Category	**Oral LD_{50}**	**Dietary LC_{50}**
Very highly toxic	< 10 mg/kg	< 50 ppm
Highly toxic	10 - 50 mg/kg	50 - 500 ppm
Moderately toxic	51 - 500 mg/kg	501 - 1000 ppm
Slightly toxic	501 - 2000 mg/kg	1001 - 5000 ppm
Practically non-toxic	> 2000 mg/kg	> 5000 ppm

4.2.1 Toxicity to Birds

As specified in the Overview Document, the Agency uses birds as a surrogate for terrestrial-phase amphibians when amphibian toxicity data are not available (U.S. EPA, 2004). No terrestrial-phase amphibian data are available for phosmet; therefore, acute and chronic bird toxicity data are used to assess the potential direct effects of phosmet to terrestrial-phase CRLFs.

4.2.1.1 Birds: Acute Exposure (Mortality) Studies

Only one avian acute oral toxicity test is available to evaluate the effect of phosmet on birds. A limit study with the mallard duck (*Anas platyrhynchos*) resulted in an LD_{50} of >2000 mg ai/kg-bw and indicates phosmet is practically nontoxic to birds on an acute oral exposure basis. Sublethal effects at the limit dose included lethargy, wing droop and loss of coordination.

Four subacute dietary toxicity studies with phosmet technical were evaluated. One ring-necked pheasant (*Phasianus colchicus*), two bobwhite quail (*Colinus virginianus)* and one mallard study showed that phosmet technical ranges from practically nontoxic to moderately toxic on a subacute dietary exposures basis with LC_{50} values ranging from 501 to >5000 mg/kg diet. The most sensitive endpoint, bobwhite quail LC_{50} of 501 mg/kg-diet, is used to evaluate potential risk to the terrestrial-phase CRLF

One subacute dietary toxicity study with mallard duck with formulated phosmet reports an LC_{50} of 3200 mg/kg-bw, suggesting formulated product is less toxic to avian species than phosmet technical on a subacute dietary exposure basis.

4.2.1.2 Birds: Chronic Exposure (Growth, Reproduction) Studies

Two avian reproduction studies are available for phosmet technical, with bobwhite quail and mallard duck. Both studies showed reductions (30%) in number of eggs produced at the LOAEC of 150 mg ai/kg-diet (the highest dose tested), with a NOAEC of 60 mg ai/kg-diet.

4.2.1.3 Terrestrial-phase Amphibian Acute and Chronic Studies

There are no data specifically evaluating the effect of phosmet on amphibians.

4.2.2 Toxicity to Mammals

Mammalian toxicity data are used to assess potential indirect effects of phosmet to the terrestrial-phase CRLF. Effects to small mammals resulting from exposure to phosmet could indirectly affect the CRLF via reduction in available food. As discussed in Section 2.5.3, over 50% of the prey mass of the CRLF may consist of vertebrates such as mice, frogs, and fish (Hayes and Tennant, 1985).

4.2.2.1 Mammals: Acute Exposure (Mortality) Studies

A summary of endpoints from the Health Effects Division (HED) risk assessment (**Appendix G**) indicates an acute oral LD_{50} for rats (*Rattus norvegicus*) dosed with phosmet is 113 mg/kg-bw; therefore, phosmet is classified as moderately toxic to mammals on an acute oral exposure basis.

4.2.2.2 Mammals: Chronic Exposure (Growth, Reproduction) Studies

A summary of endpoints from the HED risk assessment for a 2-generation reproduction study in rats indicated phosmet caused effects on adult body weights and fertility, *i.e.*, live pups/litter and decreased pup weight at exposures at the LOAEC, 6.1 mg ai/kg/day. The NOAEC is 1.5 mg ai/kg/day.

4.2.3 Toxicity to Terrestrial Invertebrates

Terrestrial invertebrate toxicity data are used to assess potential indirect effects of phosmet to the terrestrial-phase CRLF. Effects to terrestrial invertebrates resulting from exposure to phosmet could also indirectly affect the CRLF via reduction in available food.

4.2.3.1 Terrestrial Invertebrates: Acute Exposure (Mortality) Studies

Phosmet is characterized as highly toxic to terrestrial insects based on a honeybee (*Apis mellifera*) acute contact LD_{50} of 1.1 μg/bee. For the purposes of this assessment, the honeybee endpoint is used to derive RQs for terrestrial insects. This toxicity value is converted to units of μg a.i./g (of bee) by multiplying by 1 bee/0.128 g thereby resulting in an LD_{50} = 8.6 μg a.i./g.

4.2.3.2 Terrestrial Invertebrates: Open Literature Studies

There are no more sensitive data on the toxicity of phosmet to terrestrial invertebrates in the open literature available through ECOTOX. While difficult to compare directly with acute oral or acute contact honey bee studies, phosmet is lethal to the alfalfa leafcutter bee (*Megachile rotundata*; 100%), the alkali bee (*Nomia melanderi*; 63%) and the honey bee (98%), exposed to three-hour-old residues of formulated phosmet (Imidan 50% WP) at an application rate of 1.0 lb ai/A (Johansen 1972; MRID 05000837).

Additionally, most of the reported incidents with phosmet involved honey bee mortality, as discussed in Section 4.4.1.

4.2.4 Toxicity to Terrestrial Plants

There are no registrant-submitted studies available to evaluate the potential toxicity of phosmet to terrestrial plants. Given the wide range of plant species to which phosmet is applied, deleterious effects to terrestrial plant communities are not expected. However, based on label warnings against application of phosmet to sweet cherries, due to a phytotoxic effect (premature leaf drop), some adverse effects to terrestrial plants may occur.

Minimal data are available in the open literature regarding toxicity of phosmet to terrestrial plants, and generally from efficacy studies. Hagley 1983 reports a NOAEC for fruit set on apples (*Malus* spp.) of 1.12 lbs ai/A. McLeod *et al.* report a NOAEC of 1.0 lb ai/A for alfalfa (*Medicago sativa*) in a study of weevil control. In each of these cases, the reported NOAEC is the highest rate applied, which is lower than the maximum allowable single application rate of 5.95 lbs ai/A. Phytotoxic effects may occur at higher rates, although it is uncertain how much higher the rates would be before effects are seen.

Some chemicals that can be classified as organophosphate pesticides, such as glyphosate and glufosinate, are registered herbicides. The chemically-related organothiophosphate insecticide profenofos is also known to have phytotoxic effects. The PED contains phytotoxicity data on diazinon, disulfoton, fosthiazate, isofenfos and profenofos. Diazinon has reported EC_{25} values of >5.3 lbs ai/A for 6-day seedling emergence study on oat (*Avena sativa*), carrot (*Daucus carota*) and tomato (*Lycopersicon esculentum*), as well as vegetative vigor EC_{25} values of >3.2 lbs ai/A for carrot, tomato, onion (*Allium cepa*), lettuce (*Lactuca sativa*) and cucumber (*Cucumis sativum*). Reported EC_{25} values for disulfoton on the seedling emergence of nine species are >1.9 lbs ai/A as well as vegetative vigor EC_{25} values for buckwheat (*Fagopyrum esculentum*; <2.4 lbs ai/A), corn (*Zea mays*; >2.4 lbs ai/A) and onion (>2.4 lbs ai/A). The EC_{25} values for fosthiazate seedling emergence on multiple species is >6.0 lbs ai/A. The vegetative vigor EC_{25} values for fosthiazate effects to radish (*Raphanus sativus*) and two sorghum species (*Sorghum bicolor* and *S. halepense*) are >6.0 lbs ai/A, while EC_{25} values for buckwheat, pepper (*Capsicum frutescens*) and cucumber are $\geq$3.3 lbs ai/A. Reported EC_{25} values for isofenphos for multiple species seedling emergence and vegetative vigor all greater than 2.0 lbs ai/A, except for the vegetative vigor of onion, which is reported as <2.0 lbs ai/A. Profenofos seedling emergence EC_{25} value for cucumber is 0.13 lbs ai/A.

Given the large number of indeterminate endpoints, a lower-bound on the mean, typically used as a conservative estimate, is not an appropriate calculation. Given that there are few plant toxicity data for OP insecticides, the definitive endpoint for profenofos, the only organothiophosphate for which there are data (seedling emergence EC_{25} = 0.13 lbs ai/A) is used for this assessment. In the absence of other data, this endpoint represents a best available estimate of lower-bound estimate of phytotoxicity. The fact that phosmet is known to cause premature leaf drop in some sweet cherry varieties at a the label rate of 1.5 lbs ai/A, to an extent that sufficient harm is caused to the trees to warrant a label warning, reinforces the selection of the profenofos EC_{25} as a protective endpoint. Still, it is not known if other plants are affected by phosmet exposure, and it is possible that phosmet is considerably less phytototoxic than profenofos.

4.3 Use of Probit Slope Response Relationship to Provide Information on the Endangered Species Levels of Concern

The Agency uses the probit dose response relationship as a tool for providing additional information on the potential for acute direct effects to individual listed species and aquatic animals that may indirectly affect the listed species of concern (U.S. EPA 2004). As part of the risk characterization, an interpretation of acute RQ for listed species is discussed. This interpretation is presented in terms of the chance of an individual event (*i.e.*, mortality or immobilization) should exposure at the EEC actually occur for a species with sensitivity to phosmet on par with the acute toxicity endpoint selected for RQ calculation. To accomplish this interpretation, the Agency uses the slope of the dose-response relationship available from the toxicity study used to establish the acute toxicity measures of effect for each taxonomic group that is relevant to this assessment. The individual effects probability associated with the acute RQ is based on the mean estimate of the slope and an assumption of a probit dose response relationship. In addition to a single effects probability estimate based on the mean, upper and lower estimates of the effects probability are also provided to account for variance in the slope, if available.

Individual effect probabilities are calculated based on an Excel spreadsheet tool IECV1.1 (Individual Effect Chance Model Version 1.1) developed by the U.S. EPA, OPP, Environmental Fate and Effects Division (June 22, 2004). The model allows for such calculations by entering the mean slope estimate (and the 95% confidence bounds of that estimate) as the slope parameter for the pesticide. For direct effects to the aquatic-phase CRLF, the dose-response slope (3.3) for the rainbow trout is used. Where data are absent, the default slope of 4.5 is used. It should be noted that there is inherently a great deal of variation in individual effect chance, particularly when based on the default slope. The acute RQ is entered as the desired threshold. The results of the IEC model are included in the Risk Estimation section.

4.4 Incident Database Review

A review of the Ecological Incident Information System (EIIS) database for ecological incidents involving phosmet was completed on February 28, 2008. The results of this review for incidents are discussed below in Sections 4.4.1 through 4.4.3, respectively.

4.4.1 Terrestrial Incidents

There have been six reported beekill incidents involving phosmet. An application to beans in Chelan County in Washington State resulted in the loss of 102 hives in 1998 and is classified as having a “probable” association with the use of phosmet. An additional incident involving an unspecified crop, but involving the loss of 100 hives also occurred in the same county and year and is classified as having a “possible” association with phosmet use. Four incidents involving bee mortalities via phosmet drift in orchards crops have also been reported; three in Henderson County, North Carolina in 1993 and one in Merced County, California in 1997. One NC incident is classified as having a “highly probable” association with an accidental misuse of phosmet, one is classified as having a “possible” association with an accidental misuse of phosmet, and the third is classified as having an “unlikely” association with a registered use of phosmet. The one incident reported in CA is classified as having a “highly probable” association with the registered use of phosmet.

4.4.2 Plant Incidents

No incidents involving either terrestrial or aquatic plants have been reported for phosmet.

4.4.3 Aquatic Animal Incidents

There is one reported incident, involving mortality of unspecified aquatic species, via runoff from orchard application in Henderson County, North Carolina in 1997. It is classified as having a "possible" associating with an accidental misuse of phosmet.

5. Risk Characterization

Risk characterization is the integration of the exposure and effects characterizations. Risk characterization is used to determine the potential for direct and/or indirect effects to the CRLF or for modification to its designated critical habitat from the use of phosmet in CA. The risk characterization provides an estimation (Section 5.1) and a description (Section 5.2) of the likelihood of adverse effects; articulates risk assessment assumptions, limitations, and uncertainties; and synthesizes an overall conclusion regarding the likelihood of adverse effects to the CRLF or its designated critical habitat (*i.e.*, "no effect," "likely to adversely affect," or "may affect, but not likely to adversely affect").

5.1 Risk Estimation

Risk is estimated by calculating the ratio of exposure to toxicity. This ratio is the risk quotient (RQ), which is then compared to established acute and chronic risk levels of concern (LOCs) for each category evaluated. For acute exposures to the CRLF and its animal prey in aquatic habitats, as well as terrestrial invertebrates, the LOC is 0.05. For acute exposures to the terrestrial-phase CRLF and small mammalian prey items, the acute risk LOC is 0.1. The LOC for chronic risk to terrestrial-phase CRLF and its prey items, as well as acute risks to plants is 1.0.

Risk to the aquatic-phase CRLF is estimated by calculating the ratio of exposure to toxicity using 1-in-10 year peak EECs based on the labeled phosmet usage scenarios summarized in **Table 3.3** and the appropriate aquatic toxicity endpoint from **Table 4.1**. Risks to the terrestrial-phase CRLF and its prey (*e.g.* terrestrial insects, small mammals and terrestrial-phase frogs) are estimated based on exposures resulting from applications of phosmet (**Tables 3.5 through 3.6**) and the appropriate toxicity endpoint from **Table 4.3**. Risk estimates are also derived for terrestrial plants, as discussed in Section 3.3 and summarized in **Table 3.7**, based on the highest application rates of phosmet use within dry and semi-aquatic habitats surrounding use sites.

5.1.1 Exposures in the Aquatic Habitat

5.1.1.1 Direct Effects to Aquatic-Phase CRLF

Direct effects to the aquatic-phase CRLF are based on peak EECs in the standard pond and the lowest acute toxicity value for freshwater fish, *i.e.* LC_{50} of 0.070 mg/L or 70 μg/L. In order to assess direct chronic risks to the CRLF, 60-day EECs and the lowest chronic toxicity value for freshwater fish are used, in this case 0.0032 mg ai/L.

Based on the highest estimated acute exposure values and the most sensitive toxicity endpoint the acute risk to endangered species LOC is met or exceeded, by as much as two orders of magnitude, for all modeled scenarios. The probabilities of and individual mortality on the aquatic-phase CRLF range from 1 in 1.8 (55%) (for use on fruit trees) to 1 in 114,000 (for use on potato). Therefore, the determination is for a "may effect" based on potential direct acute effects to aquatic-phase CRLF (**Table 5.1**).

Based on the highest 60-day chronic exposure value (3.72 µg/L) and the estimated chronic toxicity value for freshwater fish (NOAEC=3.2 µg/L), the only the risk quotient for the unmitigated fruit tree rate exceeds the chronic risk LOC (RQ = 1.2, based on an assumed 26 applications per year). All of the remaining use patterns are below the chronic risk LOC. The preliminary determination is a "may affect" based on potential direct chronic effects to aquatic-phase CRLF from the use of phosmet on fruit trees.

Table 5.1 Summary of Acute RQs Used to Estimate Direct Effects to the Aquatic-phase CRLF using an acute LC50 = 70 µg ai/L for bluegill sunfish.

Uses	**EEC (µg/L)**	**RQ**	**Probability of Individual Effect** (1 in)
Alfalfa	9.15	0.13[b]	$5.79*10^{2}$
Tree nuts	22.6	0.32[b]	$1.95*10^{1}$
Citrus	5.83	0.08[b]	$6.78*10^{3}$
Cotton	13.2	0.19[b]	$1.16*10^{2}$
Fruit tree[2]	78.2	1.1[a,b]	$1.77*10^{0}$
Grapes	27.3	0.39[b]	$1.13*10^{1}$
Forestry[4]	23.6	0.34[b]	$1.64*10^{1}$
Potato[5]	3.52	0.05[b]	$1.14*10^{5}$
Vegetables/truck crops[6]	4.96	0.07[b]	$1.45*10^{4}$
Blueberries	4.34	0.06[b]	$3.62*10^{4}$

[a]**Exceeds acute risk to non-listed species LOC (RQ≥0.5)**
[b]**Exceeds acute risk to listed species LOC (RQ≥0.05)**

5.1.1.2 Indirect Effects to Aquatic-Phase CRLF via Reduction in Food (non-vascular aquatic plants, aquatic invertebrates, fish, and frogs)

<u>Aquatic Plants</u>

Indirect effects of phosmet to the aquatic-phase CRLF (tadpoles) via reduction in non-vascular aquatic plants in its diet are based on peak EECs from the standard pond and the lowest acute toxicity value for aquatic plants. While there are no data with which to evaluate possible effects of phosmet to aquatic plants, as described previously, effects data from other OPs are used as the best available estimates. For non-vascular aquatic plants, the lowest EC_{50} for the organophosphate insecticide naled, 34 mg ai/L, is a used as a surrogate. Using this endpoint, RQ values range from 0.1 to 2.3; all of the uses except forestry are below the acute risk LOC of 1.0. The use on fruit trees is based on a maximum presumed application rate of 26 applications per year. A more typical number of applications per year could substantially reduce exposure estimates and render risk estimates below the LOC; however, based on the one exceedance, the determination is "may effect" for indirect effects to aquatic-phase CRLF through reductions in non-vascular plant food items.

Table 5.2 Summary of Acute RQs Used to Estimate Indirect Effects to the Aquatic-phase CRLF Through Reductions in Nonvascular Plants using an EC_{50} = 34 µg ai/L (Naled).		
Uses	**EEC (µg/L)**	**RQ**
Alfalfa	9.15	0.26
Tree nuts	22.6	0.66
Citrus	5.83	0.17
Cotton	13.2	0.39
Fruit tree	78.2	**2.3***
Grapes	27.3	0.80
Forestry	23.6	0.69
Potato[5]	3.52	0.10
Vegetables/truck crops[6]	4.96	0.15
Blueberries	4.34	0.13

*Exceeds acute risk level of concern (RQ≥1.0)

Aquatic Invertebrates

Indirect acute effects to the aquatic-phase CRLF via effects to prey (invertebrates) in aquatic habitats are based on peak EECs in the standard pond and the lowest acute toxicity value (EC_{50}=2.0 µg/L) for freshwater invertebrates. For chronic risks, 21-day EECs and the lowest chronic toxicity value for invertebrates (*Daphnia magna* NOAEC=0.8 µg/L) are used to derive RQs. A summary of the acute and chronic RQ values for exposure to aquatic invertebrates (as prey items of aquatic-phase CRLFs) is provided in **Table 5.3**. The acute risk to nonlisted species LOC (RQ≥0.5) is exceeded for all modeled uses; the chronic risk LOC (RQ≥1.0) is exceeded (by up to 8-fold) for five uses (tree nuts, fruit trees, forestry, grapes and cotton). The likelihood of individual effect is 1 in 1.14 or higher, roughly 100%. The preliminary determination is "may affect" for indirect acute and chronic effect to aquatic-phase CRLF for effects to prey in aquatic habitats.

Table 5.3 Summary of Acute and Chronic RQs Used to Estimate Indirect Effects to the Aquatic-phase CRLF via Effects to Prey Base using an acute EC50=2.0 µg/L for the scud and a chronic NOAEC of 0.8 µg/L for the waterflea.				
Uses	**Peak EEC (µg/L)**	**21-day EEC (µg/L)**	**Indirect Effects Acute RQ[a]**	**Indirect Effects Chronic RQ[b]**
Alfalfa	9.15	0.470	**4.6**[a, b]	0.59
Tree nuts	22.6	1.38	**11**[a, b]	**1.7**[c]
Citrus	5.83	0.394	**2.9**[ab]	0.49
Cotton	13.2	1.20	**6.6**[a, b]	**1.5**[c]

Fruit tree	78.2	5.96	**39**[a, b]	**7.5**[c]
Grapes	27.3	1.65	**14**[a, b]	**2.1**[c]
Forestry	23.6	2.90	**12**[a, b]	**3.6**[c]
Potato	3.52	0.309	**1.8**[a, b]	0.39
Vegetables/truck crops	4.96	0.411	**2.5**[a, b]	0.51
Blueberries	4.34	0.585	**2.2**[a,b]	0.73

[a]Exceeds acute risk to non-listed species LOC (RQ≥0.5)
[b]Exceeds acute risk to listed species LOC (RQ≥0.05)
[c]Exceeds chronic risk LOC (RQ≥1.0)

Fish and Frogs

Fish and frogs also represent potential prey items of adult aquatic-phase CRLFs. RQs associated with acute and chronic direct toxicity to the CRLF (**Table 5.1**) are used to assess potential indirect effects to the aquatic-phase CRLF based on a reduction in freshwater fish and frogs as food items. Based on exceedances for all uses the preliminary determination is "may affect" for indirect effects to CRLF through potential reductions in fish and frogs that may serve as a forage base. The chronic RQ values also result in exceedances for some uses and therefore, chronic exposures "may affect" the aquatic vertebrate prey base as well.

5.1.1.3 Indirect Effects to CRLF via Reduction in Habitat and/or Primary Productivity (Aquatic Plants)

Although there are no phosmet toxicity data with which to evaluate potential risk from phosmet use to aquatic plants, as previously described, RQs are calculated using the naled EC_{50} of 0.034 mg ai/L for nonvascular plants. For vascular aquatic plants, the non-definitive EC_{50} of >1.8 mg ai/L for the organophosphate insecticide naled is used, and RQs calculated with the NOAEC of 1.8 mg ai/L are all below the LOC of 1.0. Of all the uses evaluated, only use on fruit trees exceeds the LOC. Although the relatively high exposure estimates for this use are a result of the conservative assumption that there are 26 applications per year and that more typical application rates, such as those that will be reflected on the mitigated label, would reduce the RQ below the LOC, the determination is for a may effect for indirect effects to the aquatic-phase CRLF from modification of aquatic habitat.

5.1.2 Exposures in the Terrestrial Habitat

5.1.2.1 Direct Effects to Terrestrial-phase CRLF

As previously discussed in Section 3.3, potential direct effects to terrestrial-phase CRLFs are based on foliar applications of phosmet.

Potential direct acute effects to the terrestrial-phase CRLF are typically derived by considering dose- and dietary-based EECs modeled in T-REX for a small bird (20 g) consuming small invertebrates (**Table 3.10**) and acute oral and subacute dietary toxicity endpoints for avian species. In the case of phosmet, the only acute oral toxicity estimate is a non-definitive endpoint (>2000 mg ai/kg-bw), and the chemical is characterized as practically non-toxic on an acute oral exposure basis. Therefore, only dietary-based RQs are calculated. Results are presented in **Table 5.4** and indicate that at the current maximum application rates for phosmet the acute dietary-based RQs exceed the acute risk LOC (RQ≥0.5) for application rates to tree nuts and fruit trees, citrus, cotton and grapes and the endangered species LOC (RQ≥0.1) for all of the phosmet uses modeled. The preliminary determination is "may affect" for direct acute effects to the terrestrial-phase CRLF.

Table 5.4 Acute dietary-based RQs for direct effects to the terrestrial-phase CRLF. RQs calculated using T-REX and a subacute dietary LC_{50} = 501 ppm for Bobwhite quail

Use	Dietary-based acute RQ[2]	Probability of Individual Effect (1 in)
Alfalfa	**0.27**[3]	$1.9*10^{2}$
Tree nuts	**2.3**[3]	$1.05*10^{0}$
Citrus	**0.80**[3]	$3.02*10^{0}$
Cotton	**0.66**[3]	$4.8*10^{0}$
Fruit tree	**2.3**[3]	$1.05*10^{0}$
Grapes	**0.70**[3]	$4.12*10^{0}$
Forestry	**0.46**[3]	$1.55*10^{1}$
Potato[5]	**0.29**[3]	$1.29*10^{2}$
Vegetables/truck crops[6]	**0.43**[3]	$2.02*10^{1}$
Blueberries	**0.46**[3]	$1.55*10^{1}$

Potential direct chronic effects of phosmet to the terrestrial-phase CRLF are derived by considering dietary-based exposures modeled in T-REX for a small bird (20g) consuming small invertebrates. Chronic effects are estimated using the most sensitive toxicity estimate for birds (bobwhite quail NOAEC=60 mg/kg diet). EECs are divided by toxicity value to estimate chronic dietary-based RQs. RQ values for all of the current modeled uses exceed the chronic risk LOC (RQ≥1.0) (**Table 5.5**). A 'may effect' determination is made for potential chronic effects to the terrestrial-phase CRLF.

Table 5.5 Chronic dietary-based RQs for direct effects to the terrestrial-phase CRLF. RQs calculated using T-REX.	
Use	**Chronic RQ**[5]
Alfalfa	**2.3**[6]
Tree nuts	**19**[3]
Citrus	**6.7**[3]
Cotton	**5.5**[3]
Fruit tree	**19**[3]
Grapes	**5.8**[3]
Forestry	**3.9**[3]
Potato[5]	**2.5**[3]
Vegetables/truck crops[6]	**3.6**[3]
Blueberries	**3.8**
[5]Based on estimated NOAEC = 60 ppm (for Bobwhite quail) [3]**Bold:** exceeds chronic listed species LOC (RQ≥1.0)	

5.1.2.2 Indirect Effects to Terrestrial-Phase CRLF via Reduction in Prey (terrestrial invertebrates, mammals, and frogs)

5.1.2.2.1 Terrestrial Invertebrates

In order to assess the risks of phosmet to terrestrial invertebrates, which are considered prey of CRLF in terrestrial habitats, the honey bee is used as a surrogate for terrestrial invertebrates. The toxicity value for terrestrial invertebrates is calculated by dividing the lowest available acute contact LC_{50} of 1.1 µg a.i./bee by the weight of a single adult honey bee, *i.e*., 0.128g, yielding 8.6 µg a.i/g. EECs calculated by T-REX for small and large insects (see **Table 3.11**) are divided by the calculated toxicity value (8.6 µg a.i/g) for terrestrial invertebrates to yield risk quotients (**Table 5.6**). All of the modeled uses exceed the acute risk to endangered species LOC (RQ≥0.05), for both small insect and large insect forage items. The preliminary determination is "may affect" for potential indirect effects to terrestrial-phase CRLF via potential acute effects on insects that serve in part as its dietary forage items.

Table 5.6 Summary of RQs Used to Estimate Indirect Effects to the Terrestrial-phase CRLF via Direct Effects on Terrestrial Invertebrates as Dietary Food Items using the estimated toxicity value for honey bees of 8.6 µg a.i/g.		
Use	**Small Insect RQ***	**Large Insect RQ***
Alfalfa	**16***	**1.7***
Tree nuts	**133***	**15***
Citrus	**47***	**5.2***
Cotton	**38***	**4.3***
Fruit tree	**161***	**18***
Grapes	**40***	**4.5***

Forestry	**27***	**3.0***
Potato[5]	**17***	**1.9***
Vegetables/truck crops[6]	**25***	**2.8***
Blueberries	**27***	**3.0***
* Exceeds the acute risk to listed specis LOC (RQ $\geq$ 0.05).		

5.1.2.2.2 Mammals

Risks associated with ingestion of small mammals by large terrestrial-phase CRLFs are estimated for dietary-based and dose-based exposures modeled in T-REX for a small mammal (15g) consuming short grass. Acute and chronic effects are estimated using the most sensitive acute and chronic mammalian toxicity endpoints of 113 mg/kg-bw and 1.5 mg/kg-bw, respectively. EECs (**Table 3.11**) are divided by the toxicity value to estimate acute and chronic dose-based RQs as well as chronic dietary-based RQs (**Table 5.7**). All of the modeled uses exceed the acute risk LOC (RQ$\geq$0.5) and both dose-based and dietary-based chronic risk LOCs (RQ>1.0). Therefore a preliminary "may affect" determination is made for indirect effects on terrestrial-phase CRLF based on potential acute and chronic effects on its mammalian prey items

Table 5.7 Summary of Acute and Chronic RQs* Used to Estimate Indirect Effects to the Terrestrial-phase CRLF via Direct Effects on Small Mammals as Dietary Food Items.

Use (Application Rate)	Chronic RQ		Acute RQ
	Dose-based Chronic RQ[1]	Dietary-based Chronic RQ[2]	Dose-based Acute RQ[3]
Alfalfa	**70[c]**	**12[c]**	**0.93[a, b]**
Tree nuts	**587[c]**	**101[c]**	**7.8[a, b]**
Citrus	**207[c]**	**36[c]**	**2.8[a, b]**
Cotton	**170[c]**	**29[c]**	**2.3[a, b]**
Fruit tree	**599[c]**	**104[c]**	**8.0[a, b]**
Grapes	**180[c]**	**31[c]**	**2.4[a, b]**
Forestry	**120[c]**	**21[c]**	**1.6[a, b]**
Potato	**76[c]**	**13[c]**	**1.0[a, b]**
Vegetables/truck crops	**111[c]**	**19[c]**	**1.5[a, b]**
Blueberries	**118[c]**	**20[c]**	**1.6[a, b]**

[a]Exceeds acute risk to non-listed species LOC (RQ≥0.5)
[b]Exceeds acute risk to listed species LOC (RQ≥0.1)
[c]Exceeds chronic risk LOC (RQ≥1.0)
[2] Based on dietary-based EEC and phosmet rat NOAEC = 1.5 mg/kg-bw.
[3] Based on dose-based EEC and phosmet rat acute oral LD_{50} = 113 mg/kg-bw.

5.1.2.2.3 Frogs

An additional prey item of the adult terrestrial-phase CRLF is other frogs. In order to assess risks to these organisms, dietary-based and dose-based exposures modeled in T-REX for a small bird (20g) consuming small invertebrates are used. As indicated by RQ values for direct effects to terrestrial-phase frogs (**Table 5.5),** at current maximum application rates, acute dietary-based RQ values exceed the acute risk to endangered species LOC (RQ≥0.1) for all use patterns. Therefore a preliminary "may affect" determination is made for indirect effects to terrestrial-phase CRLF based on potential effects on other terrestrial-phase amphibians that serve as prey items for the CRLF.

5.1.2.3 Indirect Effects to CRLF via Reduction in Terrestrial Plant Community (Riparian and Upland Habitat)

Potential indirect effects to the CRLF resulting from direct effects on semi-aquatic, riparian and upland vegetation are assessed using RQs from terrestrial plant seedling emergence and vegetative vigor EC_{25} data as a screen. However, no such toxicity data are available for phosmet. As described earlier, data from the organothiophosphate propenofos (EC_{25}=0.13 lbs ai/A) are used for RQ calculation in this assessment. Based on RQ values, the LOC (RQ≥1) is exceeded for terrestrial plants inhabiting semi-aquatic (wetland) areas for all of the uses evaluated; RQs for upland plants exceed the LOC for three use patterns, *i.e.*, tree nuts, fruit trees and citrus crops. For use of phosmet on tree nuts and fruit trees (orchard crops) at the highest maximum application rate and aerially applied, RQ values for spray drift alone exceed the LOC (**Table 5.8**). Based on these results, the preliminary determination is "may affect" for indirect effects to the terrestrial and aquatic-phase CRLF via effects to terrestrial plant communities, i.e., potential habitat modification.

Table 5.8 RQs* for Terrestrial Plants Inhabiting Dry and Semi-Aquatic Areas Exposed to Phosmet via Runoff and Drift. (Based on an assumed EC25 of 0.13 lbs ai/A).

Use	Application rate (lbs a.i./A)	Application method	Drift Value (%)	Spray drift RQ	Dry area RQ	Semi-aquatic area RQ
Alfalfa	1.0	Aerial	5	0.38	0.54	**1.9**
		Ground	1	<0.1	0.23	**1.6**
Tree nuts	5.95	Aerial	5	**2.3**	**3.2**	**11**
		Ground	1	0.46	**1.4**	**9.6**
Citrus	2.1	Aerial	5	0.81	**1.1**	**4.0**
		Ground	1	0.16	0.48	**3.4**
Cotton	1.0	Aerial	5	0.38	0.54	**1.9**
		Ground	1	<0.1	0.23	**1.6**
Fruit tree	5.0	Aerial	5	**1.9**	**2.7**	**9.6**
		Ground	1	0.38	**1.2**	**8.1**
Grapes	1.5	Aerial	5	0.58	0.81	**2.9**
		Ground	1	0.12	0.35	**2.4**
Forestry	1.0	Aerial	5	0.38	0.54	**1.9**
		Ground	1	<0.1	0.23	**1.6**
Potato[5]	0.9	Aerial	5	0.35	0.48	**1.7**
		Ground	1	<0.1	0.21	**1.4**
Vegetables/ truck crops[6]	1.0	Aerial	5	0.38	0.54	**1.9**
		Ground	1	<0.1	0.23	**1.6**
Blueberries	1.0	Aerial	5	0.38	0.54	**1.9**
		Ground	1	<0.1	0.23	**1.6**

* = LOC exceedances (RQ ≥ 1) are bolded and shaded.

5.1.3 Primary Constituent Elements of Designated Critical Habitat

5.1.3.1 Aquatic-Phase (Aquatic Breeding Habitat and Aquatic Non-Breeding Habitat)

Three of the four assessment endpoints for the aquatic-phase primary constituent elements (PCEs) of designated critical habitat for the CRLF are related to potential effects to aquatic and/or terrestrial plants:

- Alteration of channel/pond morphology or geometry and/or increase in sediment deposition within the stream channel or pond: aquatic habitat (including riparian vegetation) provides for shelter, foraging, predator avoidance, and aquatic dispersal for juvenile and adult CRLFs.
- Alteration in water chemistry/quality including temperature, turbidity, and oxygen content necessary for normal growth and viability of juvenile and adult CRLFs and their food source.
- Reduction and/or modification of aquatic-based food sources for pre-metamorphs (*e.g.,* algae).

The preliminary effects determination for aquatic-phase PCEs of designated habitat related to potential effects on aquatic food sources is "may affect"; additionally, effects on designated habitat due to potential effects on terrestrial plants is "may affect", based on the risk estimation provided in Sections 5.1.1.2, 5.1.1.3, and 5.1.2.3.

The remaining aquatic-phase PCE is "alteration of other chemical characteristics necessary for normal growth and viability of CRLFs and their food source." To assess the impact of phosmet on this PCE, acute and chronic freshwater fish and invertebrate toxicity endpoints, as well endpoints for aquatic non-vascular aquatic plants, are used as measures of effect. RQs for these endpoints were calculated in Sections 5.1.1.1 and 5.1.1.2. Both acute and chronic risk LOCs are exceeded for aquatic animals and the acute risk LOC is exceeded for nonvascular aquatic plants; therefore, the determination is that use may modify aquatic-phase PCEs.

5.1.3.2 Terrestrial-Phase (Upland Habitat and Dispersal Habitat)

Two of the four assessment endpoints for the terrestrial-phase PCEs of designated critical habitat for the CRLF are related to potential effects to terrestrial plants:

- Elimination and/or disturbance of upland habitat; ability of habitat to support food source of CRLFs: Upland areas within 200 ft of the edge of the riparian vegetation or dripline surrounding aquatic and riparian habitat that are comprised of grasslands, woodlands, and/or wetland/riparian plant species that provides the CRLF shelter, forage, and predator avoidance
- Elimination and/or disturbance of dispersal habitat: Upland or riparian dispersal habitat within designated units and between occupied locations within 0.7 mi of

each other that allow for movement between sites including both natural and altered sites which do not contain barriers to dispersal.

The preliminary effects determination for terrestrial-phase PCEs of designated habitat related to potential effects on terrestrial plants is "may affect", based on the risk estimation provided in Section 5.1.2.3.

The third terrestrial-phase PCE is "reduction and/or modification of food sources for terrestrial-phase juveniles and adults." To assess the impact of phosmet on this PCE, acute and chronic toxicity endpoints for birds, mammals, and terrestrial invertebrates are used as measures of effects. RQs for these endpoints were calculated in Section 5.1.2.2. The "may affect" determination of the terrestrial-phase PCE is based on potential adverse effects to food items of the CRLF.

The fourth terrestrial-phase PCE is based on alteration of chemical characteristics necessary for normal growth and viability of juvenile and adult CRLFs and their food source. Direct acute and chronic RQs for terrestrial-phase CRLFs are presented in Section 5.2.1.2. As discussed previously, the acute risk LOC is exceeded for terrestrial-phase amphibians for all use patterns. The acute risk LOC is exceeded for terrestrial invertebrates. Additionally, the chronic risk LOC is exceeded across all uses evaluated for terrestrial-phase amphibians and for mammalian food items. Based on these exceedances, the preliminary determination 'may affect' based on alteration of chemical characteristics necessary for normal growth and viability of juvenile and adult CRLF and their food source.

5.2 Risk Description

The risk description synthesizes an overall conclusion regarding the likelihood of adverse impacts leading to an effects determination (*i.e.*, "no effect," "may affect, but not likely to adversely affect," or "likely to adversely affect") for the CRLF and whether designated critical habitat may be modified.

If the RQs presented in the Risk Estimation (Section 5.1) show no direct or indirect effects for the CRLF, and no modification to PCEs of the CRLF's designated critical habitat, a "no effect" determination is made, based on the use of phosmet within the action area. However, if direct or indirect effect LOCs are exceeded or effects may modify the PCEs of the CRLF's critical habitat, the Agency concludes a preliminary "may affect" determination for the FIFRA regulatory action regarding phosmet. A summary of the results of the risk estimation (*i.e.*, "no effect" or "may affect" finding) is provided in **Table 5.10** for direct and indirect effects to the CRLF and in **Table 5.11** for the PCEs of designated critical habitat for the CRLF.

The phosmet oxon is not quantitatively assessed in this document. There are no effects data for the phosmet oxon, although, as previously stated, it could be as much as 100x more toxic than the parent. The oxon formed only in minute amounts (<0.5% of parent) in some fate studies. Although there were six detections of phosmet oxon in monitoring data, they all occurred in one month of one year in one location, so there is uncertainty in the potential for exposure to the phosmet oxon. The potential for the phosmet oxon to affect the CRLF is a source of considerable uncertainty in this assessment.

Table 5.10 Preliminary Effects Determination Summary for phosmet - Direct and Indirect Effects to CRLF

Assessment Endpoint	Preliminary Effects Determination	Basis For Preliminary Determination
Aquatic-Phase (eggs, larvae, tadpoles, juveniles, and adults)		
Survival, growth, and reproduction of CRLF individuals via direct effects on aquatic phases	May affect	RQ values for aquatic-phase CRLF exceed the acute and chronic risk LOCs
Survival, growth, and reproduction of CRLF individuals via effects to food supply (*i.e.*, freshwater invertebrates, non-vascular plants)	May affect	RQ values for aquatic invertebrates exceed the LOC
Survival, growth, and reproduction of CRLF individuals via indirect effects on habitat, cover, and/or primary productivity (*i.e.*, aquatic plant community)	May affect	Use of phosmet on fruit trees exceeds the acute risk LOC for aquatic nonvascular plants .
Survival, growth, and reproduction of CRLF individuals via effects to riparian vegetation, required to maintain acceptable water quality and habitat in ponds and streams comprising the species' current range.	May affect	RQs for plants inhabiting wetland areas exceed the LOC
Terrestrial- Phase (Juveniles and adults)		
Survival, growth, and reproduction of CRLF individuals via direct effects on terrestrial phase adults and juveniles	May affect	RQ values exceed the acute and chronic risk LOC for terrestrial-phase CRLF across all of the uses evaluated.
Survival, growth, and reproduction of CRLF individuals via effects on prey (*i.e.*, terrestrial invertebrates, small terrestrial mammals and terrestrial phase amphibians)	May affect	RQ values exceed LOC for small and large insect forage items; chronic risk LOC exceeded for mammalian prey items; acute and chronic RQ values exceed for terrestrial amphibians serving as food for terrestrial-phase CRLF.
Survival, growth, and reproduction of CRLF individuals via indirect effects on habitat (*i.e.*, riparian vegetation)	May affect	RQs for plants inhabiting wetland areas exceed the LOC

Table 5.11 Preliminary Effects Determination Summary for Phosmet – PCEs of Designated Critical Habitat for the CRLF		
Assessment Endpoint	**Preliminary Effects Determination**	**Basis For Preliminary Determination**
Aquatic-Phase CRLF PCEs (Aquatic Breeding Habitat and Aquatic Non-Breeding Habitat)		
Alteration of channel/pond morphology or geometry and/or increase in sediment deposition within the stream channel or pond: aquatic habitat (including riparian vegetation) provides for shelter, foraging, predator avoidance, and aquatic dispersal for juvenile and adult CRLFs.	May affect	RQs for plants inhabiting wetland areas exceed the LOC and RQs for upland plants exceed the LOC for some uses
Alteration in water chemistry/quality including temperature, turbidity, and oxygen content necessary for normal growth and viability of juvenile and adult CRLFs and their food source.	May affect	RQs for riparian vegetation exceed the LOC;
Alteration of other chemical characteristics necessary for normal growth and viability of CRLFs and their food source.	May affect	RQs for riparian vegetation exceed the LOC; however, aquatic plant RQs are below the LOC
Reduction and/or modification of aquatic-based food sources for pre-metamorphs (*e.g.*, algae)	May effect	RQ for use of phosmet on fruit trees exceeds the acute risk LOC for nonvascular plants.
Terrestrial-Phase CRLF PCEs (Upland Habitat and Dispersal Habitat)		
Elimination and/or disturbance of upland habitat; ability of habitat to support food source of CRLFs: Upland areas within 200 ft of the edge of the riparian vegetation or dripline surrounding aquatic and riparian habitat that are comprised of grasslands, woodlands, and/or wetland/riparian plant species that provides the CRLF shelter, forage, and predator avoidance	May affect	Terrestrial plant (riparian vegetation) RQ values exceed the LOC.
Elimination and/or disturbance of dispersal habitat: Upland or riparian dispersal habitat within designated units and between occupied locations within 0.7 mi of each other that allow for movement between sites including both natural and altered sites which do not contain barriers to dispersal	May affect	Terrestrial plant (riparian vegetation) RQ values exceed the LOC.
Reduction and/or modification of food sources for terrestrial-phase juveniles and adults	May affect	Terrestrial plant (riparian vegetation) RQ values exceed the LOC. RQ values exceed chronic risk LOC for terrestrial insects, mammals and small amphibian serving as prey for terrestrial-phase CRLF.
Alteration of chemical characteristics necessary for normal growth and viability of juvenile and adult CRLFs and their food source.	May affect	Terrestrial plant (riparian vegetation) RQ values exceed the LOC.

Following a preliminary "may affect" determination, additional information is considered to refine the potential for exposure at the predicted levels based on the life history characteristics (*i.e.*, habitat range, feeding preferences, etc.) of the CRLF. Based on the best available information, the Agency uses the refined evaluation to distinguish those actions that "may affect, but are not likely to adversely affect" from those actions that are "likely to adversely affect" the CRLF or modify designated critical habitat.

The criteria used to make determinations that the effects of an action are "not likely to adversely affect" the CRLF and its designated critical habitat include the following:

- Significance of Effect: Insignificant effects are those that cannot be meaningfully measured, detected, or evaluated in the context of a level of effect where "take" occurs for even a single individual. "Take" in this context means to harass or harm, defined as the following:
    - Harm includes significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering.
    - Harass is defined as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering.
- Likelihood of the Effect Occurring: Discountable effects are those that are extremely unlikely to occur.
- Adverse Nature of Effect: Effects that are wholly beneficial without any adverse effects are not considered adverse.

A description of the risk and effects determination for each of the established assessment endpoints for the CRLF and its designated critical habitat is provided in **Sections 5.2.1 through 5.2.3**.

5.2.1 Direct Effects

5.2.1.1 Aquatic-Phase CRLF

The aquatic-phase considers life stages of the frog that are obligatory aquatic organisms, including eggs and larvae. It also considers submerged terrestrial-phase juveniles and adults, which spend a portion of their time in water bodies that may receive runoff and spray drift containing phosmet. As discussed previously, assuming the default dose-response slope of 4.5 and at the highest acute RQ value (RQ=1.1; fruit trees) for freshwater fish, *i.e*, the surrogate for aquatic-phase amphibians, the likelihood of an individual effect is approximately 1 in 2, but may range from 1 in 1 (100%) to 1 in $1.1x10^5$. The mean likelihood of individual acute mortality supports the may affect determination for direct acute effects on aquatic-phase amphibians and together with the acute LOC exceedances results in a 'likely to adversely affect' (LAA) determination.

Chronic RQs discussed in Section 5.1.1.1 and **Table 5.1** indicate that across all but one of the uses evaluated, the chronic risk LOC is not exceeded. The highest chronic RQ value (RQ=1.2; fruit trees) does exceed the chronic risk LOC. However, it is based on the unmitigated rate and an assumed 26 applications per year, equivalent to 130 lbs ai/A/yr.

In order to estimate exposure to the aquatic-phase CRLF, PRZM/EXAMS modeling was conducted. In cases where the current labels do not reflect pending mitigation, conservative assumptions were made in terms of potential use patterns. For example, fruits trees, grapes and forestry uses were modeled assuming 26 applications per year (the maximum number of application allowed by PE5). This results in highly conservative measure of exposure. It is unlikely that 26 applications are made at the maximum application rate, and the label mitigations that are to be implemented in 2008 will limit the total phosmet application to fruit trees to under 12 lbs ai/A/yr, which would bring the RQ well under the LOC. Therefore, although the determination is 'may affect', it is 'not likely to adversely affect' (NLAA) the CRLF through direct chronic exposure to phosmet.

In order to determine the extent of the affected area in lotic (flowing) aquatic habitats, the greatest ratio of the RQ to the LOC for any endpoint for aquatic organisms is used to determine the distance downstream for concentrations to be diluted below levels that would be of concern (*i.e.* result in RQs less than the LOC). For this assessment, this applies to RQs for acute exposures of phosmet to aquatic invertebrates. The highest RQ/LOC ratio indicates the total stream kilometers within the action area that are estimated to be at or above levels of concern is 299.7 km.

5.2.1.2 Terrestrial-Phase CRLF

Acute dietary RQ values exceed the acute risk LOC for direct mortality of terrestrial-phase amphibians from phosmet across all modeled uses. The highest RQ (2.3; fruit trees), is 23 times the acute risk to listed species LOC. Refining the assessment using T-HERPS provides insight into food item contribution to the overall risk potential, but unlike the dose-based calculations, no adjustment is made for differences in the food intake between birds and amphibians. Based on T-HERPS modeling (**Table 5.12**), acute dietary RQs, and therefore estimated risk, are highest for CRLFs consuming small herbivorous prey items. However, for small amphibian prey items, RQ values based on T-HERPS across all uses are below the acute risk to listed species LOC, and for large insect insectivorous prey items, only the tree nut and fruit tree uses exceed the LOC while small insectivorous prey items exceed across all of the uses evaluated. However, because of the exceedances of the acute LOC and the high likelihood of individual effect, the determination is likely to adversely affect (LAA) the terrestrial-phase CRLF through direct acute effects.

Table 5.12. Upper Bound Kenaga, Subacute Terrestrial Herpetofauna Dietary Based Risk Quotients based on T-HERPS Model Output.										
Use	**EECs and RQs**									
	Small Insects		**Large Insects**		**Small Herbivore Mammals**		**Small Insectivore Mammals**		**Small Amphibians**	
	EEC	**RQ**	**EEC**	**RQ**	**EEC**	**RQ**	**EEC**	**RQ**	**EEC**	**RQ**
Alfalfa	171	**0.34**[b]	19	0.04	200	**0.40**[b]	13	0.02	6.0	0.01
Tree nuts	1141	**2.3**[a, b]	127	**0.25**[b]	1337	**2.7**[a, b]	84	**0.17**[b]	40	0.08
Citrus (will be deleted)	403	**0.80**[a, b]	45	0.09	472	**0.94**[a, b]	29	0.06	14	0.03
Cotton (will be deleted)	331	**0.66**[a, b]	37	0.07	388	**0.77**[a, b]	24	0.05	11	0.02
Fruit tree[2] (modeled the mitigated rate)	863	**1.7**[a, b]	96	**0.19**[b]	1010	**2.0**[a, b]	63	**0.13**[b]	30	0.06
Grapes (will be deleted)	323	**0.65**[a, b]	36	0.07	379	**0.76**[a, b]	24	0.05	11	0.02
Forestry[4] (modeled new # of apps per year)	237	**0.47**[b]	26	0.05	278	**0.55**[a, b]	17	0.03	8	0.02
Potato[5]	148	**0.29**[b]	16	0.03	173	**0.35**[b]	11	0.02	5	0.01
Vegetables/truck crops[6]	216	**0.43**[b]	24	0.05	253	**0.50**[a, b]	16	0.03	7	0.01
Blueberries	230	**0.46**[b]	26	0.05	269	**0.54**[a, b]	17	0.03	8	0.02

[a]Exceeds the acute risk to non-listed species LOC (RQ≥0.5)
[b]Exceeds the acute risk to listed species LOC (RQ≥0.1

The initial screen of chronic RQ values in TREX exceeded the chronic risk LOC for all of the uses evaluated. Refining the RQs using T-HERPS indicates that, like the acute risk values, exceedances are dependent on forage type (**Table 5.13**). For frogs consuming small insects or small herbivorous mammals, RQs exceed the LOC for all use patterns, by up to 22-fold, while for large insects and small insectivorous mammal food items exceed the chronic risk LOC for only the application rates modeled for tree nut and fruit tree uses. Small amphibian food items do not exceed the LOC for any of the modeled uses. Because of the exceedances, the determination is 'likely to adversely affect' (LAA) the terrestrial-phase CRLF through direct chronic effects to reproduction (*i.e.* decreased number of eggs).

Table 5.13. Upper Bound Kenaga, Chronic Terrestrial Herpetofauna Dietary Based Risk Quotients Based on T-HERPS Model Output.										
Use	**EECs and RQs**									
	Broadleaf Plants/ Small Insects		**Fruits/Pods/ Seeds/ Large Insects**		**Small Herbivore Mammals**		**Small Insectivore Mammals**		**Small Amphibians**	
	EEC	**RQ**	**EEC**	**RQ**	**EEC**	**RQ**	**EEC**	**RQ**	**EEC**	**RQ**
Alfalfa	136	**2.3**[a]	15	0.25	159	**2.7**[a]	10	0.17	5	0.08
Tree nuts	1141	**19**[a]	127	**2.1**[a]	1337	**22**[a]	84	**1.4**[a]	40	0.66
Citrus (will be deleted)	403	**6.7**[a]	45	0.75	472	**7.9**[a]	29	0.49	14	0.23
Cotton (will be deleted)	331	**5.5**[a]	37	0.61	388	**6.5**[a]	24	0.40	11	0.19
Fruit tree[2] (modeled the mitigated rate)	863	**14**[a]	96	**1.6**[a]	1010	**17**[a]	63	**1.1**[a]	30	0.50
Grapes (will be deleted)	323	**5.4**[a]	36	0.60	379	**6.3**[a]	24	0.39	11	0.19
Forestry[4] (modeled new # of apps per year)	237	**3.9**[a]	26	0.44	278	**4.6**[a]	17	0.29	8	0.14
Potato[5]	148	**2.5**[a]	16	0.27	173	**2.9**[a]	11	0.18	5	0.09
Vegetables/truck crops[6]	216	**3.6**[a]	24	0.40	253	**4.2**[a]	16	0.26	7	0.12
Blueberries	230	**3.8**[a]	26	0.43	269	**4.5**[a]	17	0.28	8	0.13

[a]Exceeds the chronic risk to listed and non-listed species LOC (RQ≥1.0)

Based on AgDRIFT modelling of the tree nut application rate, frank direct acute effects to the terrestrial-phase CRLF are not expected from the highest use rates greater than 900 feet from the application site. Potential chronic effects can be expected at distances greater than 900 feet for the highest use patterns, with the highest chronic RQ exceeding the LOC by a factor of three.

5.2.2 Indirect Effects (via Reductions in Prey Base)

5.2.2.1 Algae (non-vascular plants)

As discussed in Section 2.5.3, the diet of CRLF tadpoles is composed primarily of unicellular aquatic plants (*i.e.*, algae and diatoms) and detritus. Only one of the uses assessed (fruit trees) exceed the acute risk LOC for aquatic plants. As discussed before, the exceedance is based on the assumed high number (26) of applications. When EECs are based on soon-to-be implemented mitigation, the RQ for this use would be less than the LOC. Therefore, the determination is "may affect but not likely to adversely affect (NLAA)" for indirect effects to aquatic-phase CRLF based potential reductions in algae/diatoms serving as food.

5.2.2.2 Aquatic Invertebrates

The potential for phosmet to elicit indirect effects to the aquatic-phase CRLF via effects on freshwater invertebrate food items is dependent on several factors including: (1) the potential magnitude of effect on freshwater invertebrate individuals and populations; and (2) the number of prey species potentially affected relative to the expected number of species needed to maintain the dietary needs of the CRLF. Together, these data provide a basis to evaluate whether the number of individuals within a prey species is likely to be reduced such that it may indirectly affect the CRLF.

As discussed in Section 5.1.1.2 (**Table 5.3**), acute RQs exceed the acute risk to listed species LOC for all modeled uses, by a factor of up to 780X and there is a likely of individual effect of 1 in 1. Additionally, the chronic LOC is exceeded for tree nuts, cotton, fruit trees, grapes and forestry uses. Therefore, the determination is “likely to adversely effect” (LAA) for indirect effects to aquatic-phase CRLF due to reductions in aquatic invertebrates serving as food.

5.2.2.3 Fish and Aquatic-phase Frogs

Similar to the direct effects discussion for aquatic-phase CRLFs, the potential indirect acute effects to aquatic-phase CRLF from reductions in fish and other frogs serving as prey is determined to be a “likely to adversely affect” (LAA), based on the acute LOC exceedances and the likelihood of individual mortality to prey of >1 in 10 for the tree nut, fruit tree, grape and forestry uses.

5.2.2.4 Terrestrial Invertebrates

When CRLF metamorphose into juvenile and adult stages (terrestrial-phase), its diet is mainly composed of terrestrial invertebrates. As discussed in Section 5.1.2.2.1, all of the modeled uses exceed the acute risk to endangered species LOC ($RQ \geq 0.05$), up to 2500-fold based on small insect forage items and up to 300 fold based on large insect forage items. Based on a default dose-response slope of 4.5 and at the *lowest* RQ value for large insects (RQ=1.7), terrestrial insects serving as prey would have a likelihood of individual mortality of 1 in 1 (100%). Based on the LOC exceedances, the likelihood of mortality, as well as the reported incidents of mortality to honey bees, the potential effect is considered significant and the determination is ‘likely to adversely affect’ (LAA).

5.2.2.5 Mammals

Life history data for terrestrial-phase CRLFs indicate that large adult frogs consume terrestrial vertebrates, including mice. Based on the assessed uses or phosmet, all RQ values exceed the acute and chronic risk LOCs. Based on these results the determination is “may affect” based on indirect effects to terrestrial-phase CRLF from acute effects on small mammals serving as prey.

Risk estimates for potential indirect effects to terrestrial-phase CRLF via direct effects on small mammals serving as prey were further refined using T-HERPS; the acute risk LOC was still exceeded for some modeled uses. Dietary-based acute RQ values for small insectivorous mammals ranged from 0.02 to 0.17 and do not exceed the acute risk LOC, although some uses exceed the listed species LOC. Dietary-based acute risk quotients for small herbivorous mammals ranged from 0.3 to 2.7 and exceed the LOC for all uses except potato and alfalfa. Based on the LOC exceedances and a likelihood of individual effect of 1 in 1 (100%), the determination is 'likely to adversely affect' (LAA) terrestrial-phase CRLF based on adverse effects to mammals serving as food for terrestrial-phase CRLF.

5.2.2.6 Terrestrial-phase Amphibians

Terrestrial-phase adult CRLFs also consume frogs. RQ values representing direct exposures of phosmet to terrestrial-phase CRLFs are used to represent exposures of phosmet to frogs in terrestrial habitats. As discussed previously, the risk to amphibious prey items is somewhat dependent on their prey items, *i.e.* small or large insects. Therefore there is some uncertainty regarding the indirect risk to terrestrial-phase CRLF. However, the determination is a "may affect" for indirect effects to terrestrial-phase CRLFs via potential effects on frog prey items.

Risk estimates for small amphibians were further refined using T-HERPS. Based on this refinement, RQ values for frogs foraging on small insects, which are the same as in TREX, exceed the LOC, but in addition, large insect prey items are evaluated. For frogs foraging on large insect prey items, RQ values exceed acute listed species and chronic risk LOCs at the maximum application rates on tree nuts and fruit trees. The overall determination, based on LOC exceedances and likelihood of individual effects of 1 in 1 (100%) for some uses, is 'likely to adversely affect (LAA) terrestrial-phase CRLF through effects on other terrestrial-phase frogs serving as prey.

5.2.3 Indirect Effects (via Habitat Effects)

5.2.3.1 Aquatic Plants (Vascular and Non-vascular)

Aquatic plants serve several important functions in aquatic ecosystems. Non-vascular aquatic plants are primary producers and provide the autochthonous energy base for aquatic ecosystems. Vascular plants provide structure, rather than energy, to the system, as attachment sites for many aquatic invertebrates, and refugia for juvenile organisms, such as fish and frogs. Emergent plants help reduce sediment loading and provide stability to nearshore areas and lower streambanks. In addition, vascular aquatic plants are important as attachment sites for egg masses of CRLFs.

Potential indirect effects to the CRLF based on impacts to habitat and/or primary production were assessed using RQs from freshwater aquatic vascular and non-vascular plant data, in the case of phosmet, using data from other OP pesticides. Except for the use on fruit trees, none of the RQ values for either vascular on non-vascular aquatic plants exceed the LOC. Based on a more reasonable estimate of exposure for fruit trees, the potential effect on nonvascular plants was considered discountable, therefore the determination is "may affect by not likely to adversely affect" via indirect effects on the aquatic-phase CRLF through reductions in primary productivity and/or emergent vegetation.

5.2.3.2 Terrestrial Plants

Terrestrial plants serve several important habitat-related functions for the CRLF. In addition to providing habitat and cover for invertebrate and vertebrate prey items of the CRLF, terrestrial vegetation also provides shelter for the CRLF and cover from predators while foraging. Upland vegetation including grassland and woodlands provides cover during dispersal. Riparian vegetation helps to maintain the integrity of aquatic systems by providing bank and thermal stability, serving as a buffer to filter out sediment, nutrients, and contaminants before they reach the watershed, and serving as an energy source.

Using the endpoint derived for the OP insecticide propenofos, RQs for phosmet exceed LOCs for plants in both dry and semi-aquatic habitats. Phosmet is known to cause premature leaf drop in sweet cherries at 1.5 lbs ai/A. Given the wide variety of crops phosmet is used on and the apparent specificity of known phytotoxicity, it is uncertain whether sufficient impacts on terrestrial plant population would occur, either in magnitude of effect to individual species or across community composition to appreciably impact CRLF terrestrial habitat

Although it is unclear whether phosmet is likely to cause wide-spread phytotoxicity, the determination is 'likely to adversely affect' (LAA) the CRLF through effects on terrestrial plant habitats.

5.2.4 Modification to Designated Critical Habitat

5.2.4.1 Aquatic-Phase PCEs

Three of the four assessment endpoints for the aquatic-phase primary constituent elements (PCEs) of designated critical habitat for the CRLF are related to potential effects to aquatic and/or terrestrial plants:

- Alteration of channel/pond morphology or geometry and/or increase in sediment deposition within the stream channel or pond: aquatic habitat (including riparian vegetation) provides for shelter, foraging, predator avoidance, and aquatic dispersal for juvenile and adult CRLFs.
- Alteration in water chemistry/quality including temperature, turbidity, and oxygen content necessary for normal growth and viability of juvenile and adult CRLFs and their food source.
- Reduction and/or modification of aquatic-based food sources for pre-metamorphs (*e.g.,* algae).

The effects determinations for indirect effects to the CRLF via direct effects to aquatic and terrestrial plants are used to determine whether modification to critical habitat may occur. Based on surrogate toxicity data, aquatic plants are not likely to be adversely affected by the assessed uses of phosmet, but TerrPlant indicates terrestrial plants, especially wetland plants, may be adversely affected by the use of the phosmet. Reductions in the extent of riparian cover may lead to reductions in water quality due to increased runoff of sediments, decreased shading leading to increased water temperatures, and decreased vertical and horizontal habitat structure.

The remaining aquatic-phase PCE is "alteration of other chemical characteristics necessary for normal growth and viability of CRLFs and their food source." Other than impacts to algae as food items for tadpoles (discussed above), this PCE is assessed by considering direct and indirect effects to the aquatic-phase CRLF via acute and chronic freshwater fish and invertebrate toxicity endpoints as measures of effects. Based on the fact that acute and chronic RQ values exceed LOCs, uses of phosmet are expected to adversely affect the remaining aquatic-phase PCE. Therefore, the determination is "habitat modification (HM)".

5.2.4.2 Terrestrial-Phase PCEs

Two of the four assessment endpoints for the terrestrial-phase PCEs of designated critical habitat for the CRLF are related to potential effects to terrestrial plants:

- Elimination and/or disturbance of upland habitat; ability of habitat to support food source of CRLFs: Upland areas within 200 ft of the edge of the riparian vegetation or drip line surrounding aquatic and riparian habitat that are comprised of grasslands, woodlands, and/or wetland/riparian plant species that provides the CRLF shelter, forage, and predator avoidance.

- Elimination and/or disturbance of dispersal habitat: Upland or riparian dispersal habitat within designated units and between occupied locations within 0.7 mi of each other that allow for movement between sites including both natural and altered sites which do not contain barriers to dispersal.

As discussed previously, terrestrial plants may be adversely affected by phosmet and the determination is habitat modification for the two terrestrial-phase PCE through disturbance of upland habitat to support food sources of CRLF and through elimination and/or disturbance of dispersal habitat.

The third terrestrial-phase PCE is "reduction and/or modification of food sources for terrestrial-phase juveniles and adults." To assess the impact of phosmet on this PCE, acute and chronic toxicity endpoints for terrestrial invertebrates, mammals, and terrestrial-phase frogs are used as measures of effects. As discussed previously, there is a high degree of likelihood for reductions in the prey base of terrestrial-phase CRLF; therefore, the determination is habitat modification for the third terrestrial-phase CRLF PCE through reduction and/or modification of food sources for terrestrial-phase juvenile and adult CRLF.

The fourth terrestrial-phase PCE is based on alteration of chemical characteristics necessary for normal growth and viability of juvenile and adult CRLFs and their food source. Although direct effects to the terrestrial-phase CRLF are not considered likely, indirect effects through reductions in the availability of its food items are considered likely to adversely affect the species; therefore, the determination is “habitat modification (HM)” for the fourth terrestrial-phase PCE.

5.3. Nursery Use

There is a nursery and ornamental tree plantings use allowed for phosmet. Due to appreciable differences from agricultural and forestry in label language, application methods and limitations in the Agency’s standard evaluation methodologies, this use is being addressed qualitatively in this section.

The label specifies concentrations of 0.5 to 0.7 lbs ai per 100 gallons for application to nursery and ornamental plantings of nonbearing fruit and nut trees. The label also states that phosmet be applied in sufficient water to achieve complete coverage at a time when pest pressures reach an economic threshold as determined by local Extension Service, US Forest Service or similar monitoring system. Application is limited to three times per year.

One of the primary difficulties in assessing these uses is converting the concentration specified on the label to a mass per area rate, which the Agency uses to evaluate pesticide exposure to nontarget organisms. Previous assessments of nursery uses provide the basis for assumptions that can be applied to phosmet. If a tree spacing of 6 ft by 6 ft is assumed (36 ft^2 per tree), there would be 1,210 trees/A (43,560 ft^2/A divided by 36 ft^2/tree). Some nursery labels, which also specify only a concentration, suggest that some trees may require 50 gallons per tree to ensure adequate coverage. If these assumptions are applied to phosmet, it is possible that 60,500 gal/A could be applied. At 0.7 lbs ai per 100 gal, 424 lbs ai/A could theoretically be applied. This rate would by far be the highest per area application of phosmet and would be likely to adversely affect all aspects of the CRLF for large swaths around the nursery operation.

However, there are some mitigating points to consider. It is not likely that entire acreage of ornamental trees is treated at 50 gallons per tree. While theoretically possible to apply this mass per area due to the lack of specific limitation to the contrary on the label, nursery operators (growers) are typically applying pesticides to ensure maximum profitably. Given the expense involved in applying any single chemical at this rate, especially given the other chemicals (such as plant growth regulators) which are routinely applied to these high value plants (Latimer 2001), makes such application of phosmet highly unlikely.

It is also unclear that entire acres would be planted at the assumed spacing. Although larger trees may require higher volumes of carrier applied relative to smaller trees, they would also require wider spacing. Additionally, while not specified on the label, ornamentals are often (though not always) treated by hand sprayers to ensure that pesticides are only applied to the trees in need of treatment and to minimize any waste of pesticide through off-target drift or run off.

Additionally, the California PUR data suggest a much smaller mass of phosmet is applied in nursery operations. As reported in Table 2.4, nursery operations, including flowers, plants in containers and transplants have an average annual application of 27 lbs (whereas almonds have an annual application of almost 12,000 lbs), at an average rate of under 6 lbs ai/A. These data suggest that, despite the lack of label specificity, the assumptions described above, and the theoretical 424 lbs ai/A, nursery operators are not likely to apply to phosmet at the elevated rate described previously.

Nonetheless, nursery use of phosmet 'may affect' the CRLF in one or more of the assessment criteria, especially locally, and the overall LAA determination is unaffected by the uncertainties involved with this use pattern.

6. Uncertainties

As discussed in the problem formulation, the process used in assessing the risks associated with the currently labeled uses of phosmet is consistent with the Agency's document entitled "*Overview of the Ecological Risk Assessment Process in the Office of Pesticide Programs*" (http://www.epa.gov/oppfead1/endanger/consultation/ecorisk-overview.pdf). Throughout this document a number of uncertainties have been characterized. These uncertainties arise from a lack of data and *in lieu* of data the Agency relies on standard assumptions. The Overview Document provides a relatively thorough review of the uncertainties and underlying assumptions associated with screening-level risk assessments; however, some areas of uncertainty are also described below.

6.1 Exposure Assessment Uncertainties

6.1.1 Maximum Use Scenario

The screening-level risk assessment focuses on characterizing potential ecological risks resulting from a maximum use scenario, which is determined from labeled statements of maximum application rate and number of applications with the shortest time interval between applications. The frequency at which actual uses approach this maximum use scenario may be dependant on pest resistance, timing of applications, cultural practices, and market forces.

6.1.2 Aquatic Exposure Modeling of Phosmet

The standard ecological water body scenario (standard farm pond) used to calculate potential aquatic exposure to pesticides is intended to represent conservative estimates, and to avoid underestimations of the actual exposure. The standard scenario consists of application to a 10-hectare field bordering a 1-hectare, 2-meter deep (20,000 m^3) pond with no outlet. Exposure estimates generated using the standard farm pond are intended to represent a wide variety of vulnerable water bodies that occur at the top of watersheds including prairie pot holes, playa lakes, wetlands, vernal pools, man-made and natural ponds, and intermittent and lower order streams. As a group, there are factors that make these water bodies more or less vulnerable than the standard farm pond. Static water bodies that have larger ratios of pesticide-treated drainage area to water body volume would be expected to have higher peak EECs than the standard farm pond. These water bodies will be either smaller in size or have larger drainage areas. Smaller water bodies have limited storage capacity and thus may overflow and carry pesticide in the discharge, whereas the standard farm pond has no discharge. As watershed size increases beyond 10-hectares, it becomes increasingly unlikely that the entire watershed is planted with a single crop that is all treated simultaneously with the pesticide. Headwater streams can also have peak concentrations higher than the standard farm pond, but they likely persist for only short periods of time and are then carried and dissipated downstream.

The Agency acknowledges that there are some unique aquatic habitats that are not accurately captured by this modeling scenario and modeling results may, therefore, under- or over-estimate exposure, depending on a number of variables. For example, aquatic-phase CRLFs may inhabit water bodies of different size and depth and/or are located adjacent to larger or smaller drainage areas than that modeled with the standard farm pond. The Agency does not currently have sufficient information regarding the hydrology of these aquatic habitats to develop a specific alternate scenario for the CRLF. CRLFs prefer habitat with perennial (present year-round) or near-perennial water and do not frequently inhabit vernal (temporary) pools because conditions in these habitats are generally not suitable (Hayes and Jennings 1988). Therefore, the standard farm pond is assumed to be representative of exposure to aquatic-phase CRLFs. In addition, the Services have agreed that the existing standard farm pond represents the best currently available approach for estimating aquatic exposure to pesticides (USFWS/NMFS 2004).

In general, the linked PRZM/EXAMS model produces estimated aquatic concentrations that are expected to be exceeded once within a ten-year period. The Pesticide Root Zone Model is a process or “simulation” model that calculates what happens to a pesticide in an agricultural field on a day-to-day basis. It considers factors such as rainfall and plant transpiration of water, as well as how and when the pesticide is applied. It has two major components: hydrology and chemical transport. Water movement is simulated by the use of generalized soil parameters, including field capacity, wilting point, and saturation water content. The chemical transport component can simulate pesticide application on the soil or on the plant foliage. Dissolved, adsorbed, and vapor-phase concentrations in the soil are estimated by simultaneously considering the processes of pesticide uptake by plants, surface runoff, erosion, decay, volatilization, foliar wash-off, advection, dispersion, and retardation.

Uncertainties associated with each of these individual components add to the overall uncertainty of the modeled concentrations. Additionally, model inputs from the environmental fate degradation studies are chosen to represent the upper confidence bound on the mean values that are not expected to be exceeded in the environment approximately 90 percent of the time. Mobility input values are chosen to be representative of conditions in the environment. The natural variation in soils adds to the uncertainty of modeled values. Factors such as application date, crop emergence date, and canopy cover can also affect estimated concentrations, adding to the uncertainty of modeled values. Factors within the ambient environment such as soil temperatures, sunlight intensity, antecedent soil moisture, and surface water temperatures can cause actual aquatic concentrations to differ for the modeled values.

Unlike spray drift, tools are currently not available to evaluate the effectiveness of a vegetative setback on runoff and loadings. The effectiveness of vegetative setbacks is highly dependent on the condition of the vegetative strip. For example, a well-established, healthy vegetative setback can be a very effective means of reducing runoff and erosion from agricultural fields. Alternatively, a setback of poor vegetative quality or a setback that is channelized can be ineffective at reducing loadings. Until such time as a quantitative method to estimate the effect of vegetative setbacks on various conditions on pesticide loadings becomes available, the aquatic exposure predictions are likely to overestimate exposure where healthy vegetative setbacks exist and underestimate exposure where poorly developed, channelized, or bare setbacks exist.

6.1.4 Usage Uncertainties

County-level usage data were obtained from California's Department of Pesticide Regulation Pesticide Use Reporting (CDPR PUR) database. Four years of data (2002 – 2005) were included in this analysis because statistical methodology for identifying outliers, in terms of area treated and pounds applied, was provided by CDPR for these years only. No methodology for removing outliers was provided by CDPR for 2001 and earlier pesticide data; therefore, this information was not included in the analysis because it may misrepresent actual usage patterns. CDPR PUR documentation indicates that errors in the data may include the following: a misplaced decimal; incorrect measures, area treated, or units; and reports of diluted pesticide concentrations. In addition, it is possible that the data may contain reports for pesticide uses that have been cancelled. The CPDR PUR data does not include home owner applied pesticides; therefore, residential uses are not likely to be reported. As with all pesticide usage data, there may be instances of misuse and misreporting. The Agency made use of the most current, verifiable information; in cases where there were discrepancies, the most conservative information was used.

6.1.5 Terrestrial Exposure Modeling of Phosmet

The Agency relies on the work of Fletcher et al. (1994) for setting the assumed pesticide residues in wildlife dietary items. These residue assumptions are believed to reflect a realistic upper-bound residue estimate, although the degree to which this assumption reflects a specific percentile estimate is difficult to quantify. It is important to note that the field measurement efforts used to develop the Fletcher estimates of exposure involve highly varied sampling techniques. It is entirely possible that much of these data reflect residues averaged over entire above ground plants in the case of grass and forage sampling.

It was assumed that ingestion of food items in the field occurs at rates commensurate with those in the laboratory. Although the screening assessment process adjusts dry-weight estimates of food intake to reflect the increased mass in fresh-weight wildlife food intake estimates, it does not allow for gross energy differences. Direct comparison of a laboratory dietary concentration- based effects threshold to a fresh-weight pesticide residue estimate would result in an underestimation of field exposure by food consumption by a factor of 1.25 – 2.5 for most food items.

Differences in assimilative efficiency between laboratory and wild diets suggest that current screening assessment methods do not account for a potentially important aspect of food requirements. Depending upon species and dietary matrix, bird assimilation of wild diet energy ranges from 23 – 80%, and mammal's assimilation ranges from 41 – 85% (U.S. Environmental Protection Agency, 1993). If it is assumed that laboratory chow is formulated to maximize assimilative efficiency (*e.g.*, a value of 85%), a potential for underestimation of exposure may exist by assuming that consumption of food in the wild is comparable with consumption during laboratory testing. In the screening process, exposure may be underestimated because metabolic rates are not related to food consumption.

For the terrestrial exposure analysis of this risk assessment, a generic bird or mammal was assumed to occupy either the treated field or adjacent areas receiving a treatment rate on the field. Actual habitat requirements of any particular terrestrial species were not considered, and it was assumed that species occupy, exclusively and permanently, the modeled treatment area. Spray drift model predictions suggest that this assumption leads to an overestimation of exposure to species that do not occupy the treated field exclusively and permanently.

6.2 Effects Assessment Uncertainties

6.2.1 Age Class and Sensitivity of Effects Thresholds

It is generally recognized that test organism age may have a significant impact on the observed sensitivity to a toxicant. The acute toxicity data for fish are collected on juvenile fish between 0.1 and 5 grams. Aquatic invertebrate acute testing is performed on recommended immature age classes (*e.g.*, first instar for daphnids, second instar for amphipods, stoneflies, mayflies, and third instar for midges).

Testing of juveniles may overestimate toxicity at older age classes for pesticide active ingredients that act directly without metabolic transformation because younger age classes may not have the enzymatic systems associated with detoxifying xenobiotics. In so far as the available toxicity data may provide ranges of sensitivity information with respect to age class, this assessment uses the most sensitive life-stage information as measures of effect for surrogate aquatic animals, and is therefore, considered as protective of the CRLF.

6.2.2 Use of Surrogate Species Effects Data

Guideline toxicity tests and open literature data on phosmet are not available for frogs or any other aquatic-phase amphibian; therefore, freshwater fish are used as surrogate species for aquatic-phase amphibians. Therefore, endpoints based on freshwater fish ecotoxicity data are assumed to be protective of potential direct effects to aquatic-phase amphibians including the CRLF, and extrapolation of the risk conclusions from the most sensitive tested species to the aquatic-phase CRLF is likely to overestimate the potential risks to those species. Efforts are made to select the organisms most likely to be affected by the type of compound and usage pattern; however, there is an inherent uncertainty in extrapolating across phyla. In addition, the Agency's LOCs are intentionally set very low, and conservative estimates are made in the screening level risk assessment to account for these uncertainties.

As previously noted, the avian effects assessment is based on dietary endpoints only. There is an acute dose-based endpoint available, but it is greater than the Agency's limit dose (>2000 mg ai/kg-bw). The endpoint is based on the mallard duck and is the only available LD_{50} value. The mallard duck also has a nondefinitive subacute dietary toxicity endpoint, also greater than the Agency's limit dose (>5000 mg ai/kg-diet), while dietary endpoint used in this study is from the bobwhite quail. It is not known if a dose-based study with the bobwhite quail would result in a definitive endpoint, so there is uncertainty in the assessment because only the dietary endpoint is used to derive RQs.

6.2.3 Sublethal Effects

When assessing acute risk, the screening-level assessment relies on the acute mortality endpoint as well as a suite of sublethal responses to the pesticide, as determined by the testing of species response to chronic exposure conditions and subsequent chronic risk assessment. Consideration of additional sublethal data in the assessment is exercised on a case-by-case basis and only after careful consideration of the nature of the sublethal effect measured and the extent and quality of available data to support establishing a plausible relationship between the measure of effect (sublethal endpoint) and the assessment endpoints.

No data are available on the sublethal effects of phosmet; however, the absence of data cannot be construed as the absence of effects. To the extent to which sublethal effects are not considered in this assessment, the potential direct and indirect effects of phosmet on CRLF may be underestimated.

6.2.4 Location of Wildlife Species

For the terrestrial exposure analysis of this risk assessment, a generic bird or mammal was assumed to occupy either the treated field or adjacent areas receiving a treatment rate on the field. Actual habitat requirements of any particular terrestrial species were not considered, and it was assumed that species occupy, exclusively and permanently, the modeled treatment area. Spray drift model predictions suggest that this assumption leads to an overestimation of exposure to species that do not occupy the treated field exclusively and permanently.

6.2.6 Absence of Aquatic and Terrestrial Plant Toxicity Data

The lack of phytotoxicity data for phosmet is a source of considerable uncertainty in this assessment. The use of the profenofos terrestrial EC_{25} endpoint as a surrogate for phosmet is a best estimate given the lack of phosmet-specific data, and may not represent the actual phytotoxicity potential of phosmet. Less uncertain is the surrogate data for aquatic plants, as a QSAR estimate is available for green algae which supports the selected endpoint.

7. Risk Conclusions

In fulfilling its obligations under Section 7(a)(2) of the Endangered Species Act, the information presented in this endangered species risk assessment represents the best data currently available to assess the potential risks of phosmet to the CRLF and its designated critical habitat.

Based on the best available information, the Agency makes a Likely to Adversely Affect (LAA) determination for the CRLF from the use of phosmet in California. Additionally, the Agency has determined that there is the potential for modification of CRLF designated critical habitat from the use of the chemical.

Based on the conclusions of this assessment, a formal consultation with the U. S. Fish and Wildlife Service under Section 7 of the Endangered Species Act should be initiated. Attachment 2, which includes information on the baseline status and cumulative effects for the CRLF, can be used during this consultation to provide background information on past US Fish and Wildlife Services biological opinions associated with the CRLF.

A summary of the risk conclusions and effects determinations for the CRLF and its critical habitat, given the uncertainties discussed in Section 6, is presented in Tables 7.1 and 7.2.

The overall determination for the effects of phosmet on the CRLF is LAA. Based on the conclusions of this assessment, a formal consultation with the U. S. Fish and Wildlife Service under Section 7 of the Endangered Species Act should be initiated.

Table 7.1 Effects Determination Summary for Direct and Indirect Effects of phosmet on the CRLF		
Assessment Endpoint	**Effects Determination[1]**	**Basis for Determination**
Aquatic-Phase CRLF (Eggs, Larvae, and Adults)		
Direct Effects: Survival, growth, and reproduction of CRLF individuals via direct effects on aquatic phases	**LAA**	RQ values for CRLF exceed the acute and chronic LOCs.
Indirect Effects: Survival, growth, and reproduction of CRLF individuals via effects to food supply (*i.e.*, freshwater invertebrates, non-vascular plants, fish, and frogs)	Freshwater invertebrates: **LAA**	RQ values for freshwater invertebrates exceed acute and chronic LOCs
	Non-vascular aquatic plants: **NLAA**	RQ values for non-vascular aquatic plants are below the LOC for all uses except fruit trees. Exposure estimates for the use on fruit trees is considered high end and when more realistic application rates are considered, RQ values for nonvascular plants from the use of phosmet on fruit trees would likely fall below the LOC.
	Fish and frogs: **LAA**	RQ values for freshwater vertebrates (fish and amphibians) exceed acute and chronic LOCs.
Indirect Effects: Survival, growth, and reproduction of CRLF individuals via indirect effects on habitat, cover, and/or primary productivity (*i.e.*, aquatic plant community)	Non-vascular aquatic plants: **NLAA**	RQ values for non-vascular aquatic plants are below the LOC for all uses except fruit trees. Exposure estimates for the use on fruit trees is considered high end and when more realistic application rates are considered, RQ values for nonvascular plants from the use of phosmet on fruit trees would likely fall below the LOC.
	Vascular aquatic plants: **NE**	RQ values for vascular aquatic plants are below the LOC.
Indirect Effects: Survival, growth, and reproduction of CRLF individuals via effects to riparian vegetation, required to maintain acceptable water quality and habitat in ponds and streams comprising the species' current range.	**LAA**	Terrestrial plant RQ values are exceeded and riparian vegetation may be adversely affected which in turn could indirectly affect water quality and habitat in ponds and streams comprising the species' current range.
Terrestrial-Phase CRLF (Juveniles and adults)		
Direct Effects: Survival, growth, and reproduction of CRLF individuals via direct effects on terrestrial phase adults and juveniles	**LAA**	Acute and chronic RQ values exceed the LOCs and have a likelihood of acute effects of up to 100%, depending on the use.
Indirect Effects: Survival, growth, and reproduction of CRLF individuals via effects on prey (*i.e.*, terrestrial invertebrates, small terrestrial vertebrates, including mammals and terrestrial phase amphibians)	Terrestrial invertebrates: **LAA**	Both small and large insect RQs exceed the LOC. Terrestrial insects serving as prey would have a likelihood of individual mortality of 100%.
	Mammals: **LAA**	Acute and chronic RQ values exceed the LOCs; therefore, the determination is for a likely to adversely affect (LAA) terrestrial-phase CRLF based on indirect adverse chronic effects on mammals serving as food for terrestrial-phase CRLF
	Frogs: **LAA**	Acute and chronic RQ values exceed the LOCs; therefore, the determination is for a likely to adversely affect (LAA) terrestrial-phase CRLF based on indirect adverse chronic effects on mammals serving as food for terrestrial-phase CRLF

Indirect Effects: Survival, growth, and reproduction of CRLF individuals via indirect effects on habitat (*i.e.*, riparian vegetation)	**LAA**	Terrestrial plant RQ values, based on bridged data, exceed the LOC for semi-aquatic plants for all uses

Table 7.2 Effects Determination Summary for the Critical Habitat Impact Analysis

Assessment Endpoint	Effects Determination[1]	Basis for Determination
Aquatic-Phase CRLF PCEs (Aquatic Breeding Habitat and Aquatic Non-Breeding Habitat)		
Alteration of channel/pond morphology or geometry and/or increase in sediment deposition within the stream channel or pond: aquatic habitat (including riparian vegetation) provides for shelter, foraging, predator avoidance, and aquatic dispersal for juvenile and adult CRLFs.	**HM**	Although aquatic plants are not affected by the assessed uses of phosmet, terrestrial plants may be adversely affected from the use of phosmet. Reductions in the extent of riparian cover may lead to reductions in water quality due to increased runoff of sediments, decreased shading leading to increased water temperatures, and decreased structure
Alteration in water chemistry/quality including temperature, turbidity, and oxygen content necessary for normal growth and viability of juvenile and adult CRLFs and their food source.[5]	**HM**	
Alteration of other chemical characteristics necessary for normal growth and viability of CRLFs and their food source.	**HM**	
Reduction and/or modification of aquatic-based food sources for pre-metamorphs (*e.g.*, algae)	**HM**	RQ values for freshwater vertebrates (fish and amphibians) exceed both the acute and chronic LOCs.
Terrestrial-Phase CRLF PCEs (Upland Habitat and Dispersal Habitat)		
Elimination and/or disturbance of upland habitat; ability of habitat to support food source of CRLFs: Upland areas within 200 ft of the edge of the riparian vegetation or dripline surrounding aquatic and riparian habitat that are comprised of grasslands, woodlands, and/or wetland/riparian plant species that provides the CRLF shelter, forage, and predator avoidance	**HM**	Terrestrial plant RQ values exceed the LOC. Because terrestrial plants may be adversely affected by phosmet, the determination is for a likely to adversely affect the two terrestrial-phase PCE through disturbance of upland habitat to support food sources of CRLF and through elimination and/or disturbance of dispersal habitat.
Elimination and/or disturbance of dispersal habitat: Upland or riparian dispersal habitat within designated units and between occupied locations within 0.7 mi of each other that allow for movement between sites including both natural and altered sites which do not contain barriers to dispersal	**HM**	
Reduction and/or modification of food sources for terrestrial phase juveniles and adults	**HM**	As an insecticide, reductions in the prey base of terrestrial-phase CRLF are likely; therefore, the determination is for a likely to adversely affect (LAA) the third terrestrial-phase CRLF PCE through reduction and/or modification of food sources for terrestrial-phase juvenile and adult CRLF.
Alteration of chemical characteristics necessary for normal growth and viability of juvenile and adult CRLFs and their food source.	**HM**	Indirect effects through reductions in the availability of its food items are considered likely to adversely affect the species; therefore, the determination is for a likely to adversely affect (LAA) the fourth terrestrial-phase PCE.

[1] NE = No effect; HM = Habitat modification

When evaluating the significance of this risk assessment's direct/indirect and adverse habitat modification effects determinations, it is important to note that pesticide

[5] Physico-chemical water quality parameters such as salinity, pH, and hardness are not evaluated because these processes are not biologically mediated and, therefore, are not relevant to the endpoints included in this assessment.

exposures and predicted risks to the species and its resources (*i.e.*, food and habitat) are not expected to be uniform across the action area. In fact, given the assumptions of drift and downstream transport (*i.e.*, attenuation with distance), pesticide exposure and associated risks to the species and its resources are expected to decrease with increasing distance away from the treated field or site of application. Evaluation of the implication of this non-uniform distribution of risk to the species would require information and assessment techniques that are not currently available. Examples of such information and methodology required for this type of analysis would include the following:

- Enhanced information on the density and distribution of CRLF life stages within specific recovery units and/or designated critical habitat within the action area. This information would allow for quantitative extrapolation of the present risk assessment's predictions of individual effects to the proportion of the population extant within geographical areas where those effects are predicted. Furthermore, such population information would allow for a more comprehensive evaluation of the significance of potential resource impairment to individuals of the species.
- Quantitative information on prey base requirements for individual aquatic- and terrestrial-phase frogs. While existing information provides a preliminary picture of the types of food sources utilized by the frog, it does not establish minimal requirements to sustain healthy individuals at varying life stages. Such information could be used to establish biologically relevant thresholds of effects on the prey base, and ultimately establish geographical limits to those effects. This information could be used together with the density data discussed above to characterize the likelihood of adverse effects to individuals.
- Information on population responses of prey base organisms to the pesticide. Currently, methodologies are limited to predicting exposures and likely levels of direct mortality, growth or reproductive impairment immediately following exposure to the pesticide. The degree to which repeated exposure events and the inherent demographic characteristics of the prey population play into the extent to which prey resources may recover is not predictable. An enhanced understanding of long-term prey responses to pesticide exposure would allow for a more refined determination of the magnitude and duration of resource impairment, and together with the information described above, a more complete prediction of effects to individual frogs and potential modification to critical habitat.

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